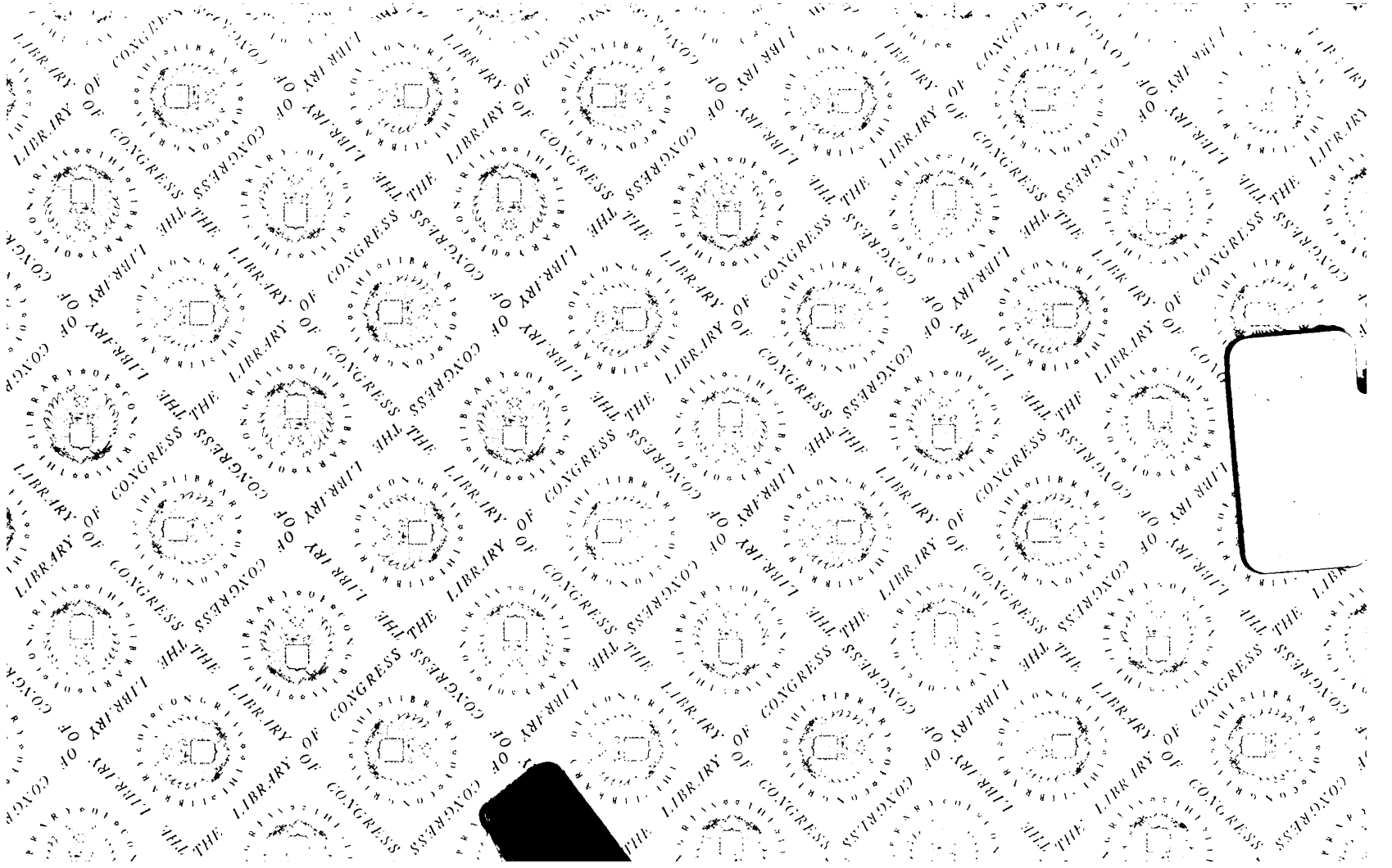

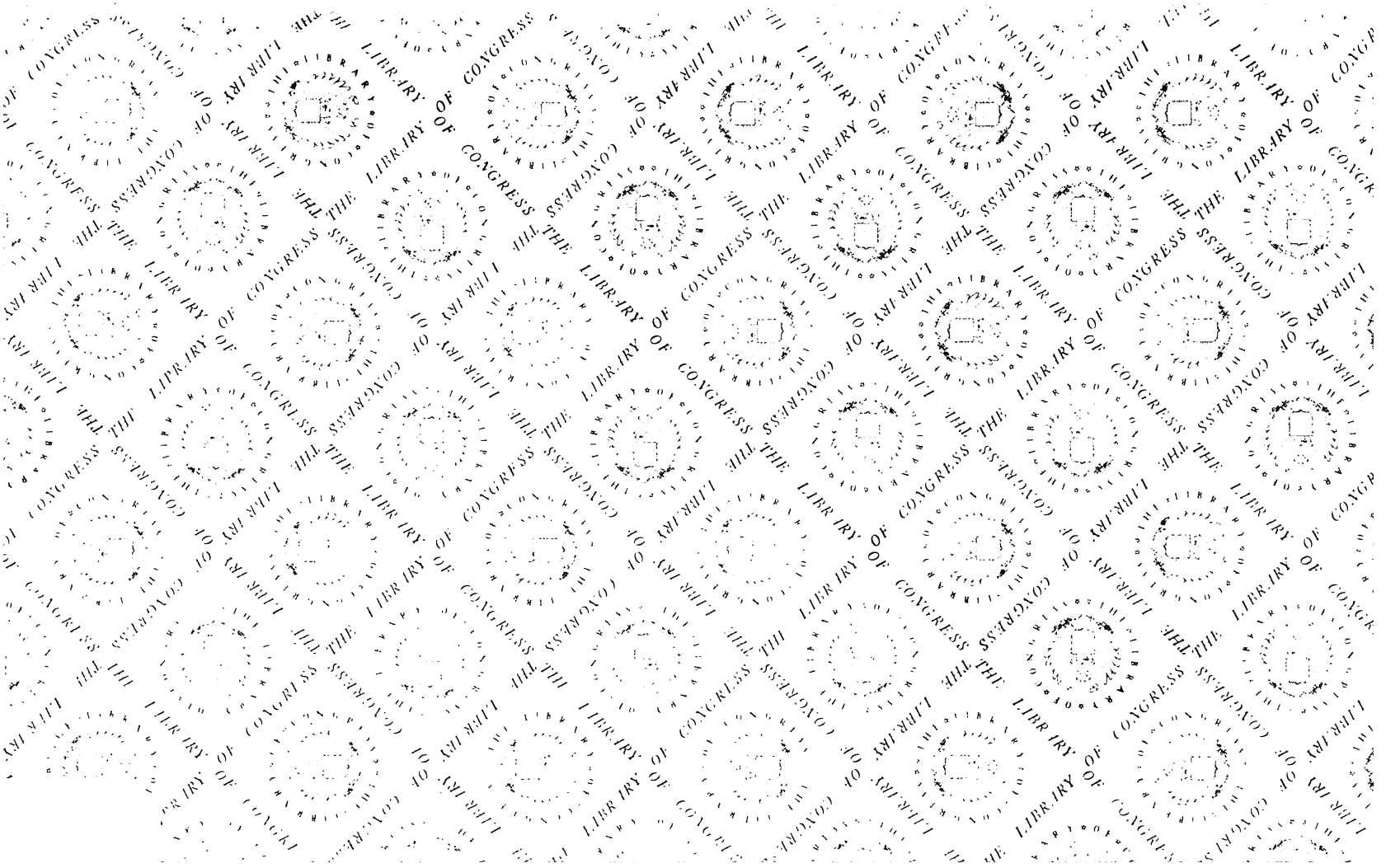
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THE METRIC SYSTEM.

HEARINGS BEFORE THE COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,

HOUSE OF REPRESENTATIVES,

UNITED STATES,

ON

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METRIC SYSTEM.

STATEMENT OF C. O. MAILLOUX, ESQ.

The CHAIRMAN. Gentlemen, we have here Mr. Mailloux, a consulting electrical engineer. Mr. Mailloux, we will be glad to hear what you have to say now relative to the metric system, or relative to the proposed legislation before this committee.

Mr. MAILLOUX. Gentlemen, I think that I can compress into a few words what has not already been said on this subject. I am aware that it has received your attention at this session and that it has received the attention of committees at previous sessions, and it has given rise to a great deal of acerbity and controversy between the contending factions for and against it.

I take a great deal of interest in the metric system and am a strong believer in it. I may as well state at the beginning, so as to anticipate any cross-examination in that respect, that I come here as a friend and as a partisan of the metric system. I will also say that, like the gentleman who preceded me, I learned it so easily and so long ago that I can scarcely remember when it was that I did not, in my conscious intellectual existence, know something of the metric system and use it.

I want to say, without wishing to obtrude on any previous discussion, that I do not think that the difficulty of introducing the metric system will be as great as some of its antagonists would have you believe. So far as the intelligence required to use it is concerned, I think it may be said that all the children who are going to school now know of it, and in many cases know how to use it, and that all men who have graduated from technological and scientific schools in the last fifteen or twenty years know how to use it—even perhaps for a longer period than that. My own vocation is that of a consulting engineer. I am not connected with any manufacturing interest whatever. My business is to serve clients in the capacity of a technical adviser. I prepare plans and specifications for power plants and direct their construction and equipment. I bear the same relation to my clients that an architect does to his clients. In fact, my position may be considered equivalent to that of an architect, excepting that I am an architect in the building of power plants, power stations, and electrical installations of all kinds.

Therefore I know more of the uses of the metric system from the standpoint of the engineer than from any other standpoint. But it is exactly because I am an engineer and because I pretend to know something of the uses of the metric system from the engineering standpoint that I thought it my duty to appear before this committee. I want to point out the fact that we are living in a century, in an age, of engineering development and progress, and that the function of

engineering, or the engineering "factor," in our life is becoming more important every day. The United States Navy and the Army afford striking examples of this. I was this morning at the War College and had impressed upon my mind by some of the things I saw and learned there the great, important part which engineering is going to play in all future wars.

The moment that we concede the fact of the importance of engineering, not only in commercial life, but even in our political life, since the Army and Navy are involved in it, we readily see that it must be of great importance as a factor everywhere. I look upon this committee as charged—I do not wish to dictate to the committee what its duties are, and I say this with all due deference—but in my modest way I look upon the function of any committee of the United States Government as being to inquire into that which is calculated to do good to the community, not only in a commercial sense, but even in an intellectual sense; and it is there, especially, that the metric system appeals to me.

We live in an age where every bit of nervous energy counts, where everything is essential to our progress in the way of nervous energy. We want to save it; we want to utilize it as much as possible. As an engineer I have been impressed hundreds of times with the great desirability of a system of measures by which the amount of mental "wear and tear" may be reduced. And while the engineer, because he has so much to do with measures and calculations, has better opportunities to notice these things than the layman, yet it is not difficult to show that the possibility of reducing mental wear and tear exists even in the sphere of the layman.

I found an article in Cassier's Magazine, which I have here, which I presume is a copy of testimony given before this committee or a previous committee, on "The metric system fallacy," and I find some statements made there which are very pertinent to this question of economy of human nervous energy. I asked myself whether a little skillful cross-examination on the part of this committee would not have riddled to pieces a great many of the statements that are made here. I want to bring to your attention some remarks, for instance, which bear exactly and precisely upon the point that I wish to make of the importance of the metric system as a means of simplification of "brain work" in ordinary computations.

The CHAIRMAN. What is the date of that magazine?

Mr. MAILLOUX. This article is published in Cassier's Magazine for February, 1906, volume 29, No. 4. The heading of the article states that—

The following pages of Mr. McFarland's testimony on the subject, given some time ago before the American Congressional Committee on Coinage, Weights, and Measures—

Mr. McFarland admits the three principal advantages of the metric system. In fact, I find nobody that questions them. I want to say, before I forget it, that I do not know of an engineer in this country, and I know many of them, that is under 40 years of age who is not unqualifiedly in favor of the metric system, if he has taken care to investigate it, without prejudice, or to look into the system from the standpoint of what it means and what it can do for individuals as well as for industries.

I stated, recently, in a letter to the London Electrician, in reply to a correspondent who attempted to "translate" some previously published statements of mine as in favor of decimalizing the existing system and using it as a substitute for the metric system, that I did not believe in trying to patch up an old, obsolete system. The following is a quotation from my letter to the editor of the London Electrician:

[Extract from the Electrician (London), Volume LVI, page 401, published (December 22) 1905.]

The truth is that I am not at all in sympathy with any proposition or attempt on behalf of the English-speaking races, or of any other races for that matter, to "patch" up an obsolete system of units. When "International" says, at the beginning of the third paragraph, "In America we find a growing willingness to change," he speaks truly, but unfortunately, for his view, what he says is not true in the sense or in the direction that he believes, or that he would evidently prefer. The kind of "change" which young American engineers want, which they (almost without exception) advocate, which they hope to have, which they will have, and which they would already have (were it not for the few remaining "older" conservative "fossils" in the engineering profession), is, I need scarcely say, the metric system. I could have said this in my previous communication, and I could also have added that I myself have been, from the beginning of my professional career, an enthusiastic partisan and a zealous advocate of the metric system, as my colleagues well know in America.

* * * * * * *

The 2,000-pound ton, known as the "American ton," or "short ton," is not, as your correspondent's reference would make it seem, an innovation on my part, but, as is well known, is an American institution of long standing. I am not trying, either by guerilla warfare or other methods, to "reform" the existing absurd system. I simply wish to use it, so long as we are obliged to do so, in the simplest, or, better say, the least cumbrous manner consistent with the existing units or measures. The British ton of 2,240 pounds does not excite additional enthusiasm in me on account of the fact, mentioned by "International," that it is only 1.5 per cent "out," as compared with the metric ton. I consider this fact to be not an "attenuating" circumstance, but an "exasperating" circumstance, and one which applies to all "counterfeits" or "imitations" of really good things, in science as in art.

(Thereupon, the hour of 12 o'clock having arrived, the committee took a recess until 2 o'clock p. m.)

AFTER RECESS.

STATEMENT OF C. O. MAILLOUX, ESQ.—Continued.

Mr. MAILLOUX. I will state, Mr. Chairman and gentlemen, that I have not prepared any formal statement. I assumed that you did not want very much rhetoric.

The CHAIRMAN. No; what we want is what you think about this thing.

Mr. MAILLOUX. I assumed that you wanted a statement of my opinion of the system.

The CHAIRMAN. And why you think as you do.

Mr. MAILLOUX. Yes. Now, I have made notes of some of the statements which were made in previous testimony before this committee, and I want to refer to some of them as illustrating the manner in which cross-examination might have successfully defeated some of the arguments made against the metric system in the endeavor to depreciate its merits. Mr. McFarland, while admitting the great

advantage of the logical relation of the units of length, volume, and weight in the system, says:

> In our work we are mainly concerned with the inch, its decimal multiples and submultiples, both for length, surface, and volume, and the weights of materials as calculated from them.

Then he goes on and explains that while the unit of weight has no logical relation to the linear unit nevertheless the determination of the weight of any given material from the cubic capacity is just as simple as in the metric system, "as will be explained under the next heading." Then he goes on and explains, in the next heading, that we have to multiply the result in the metric system by a factor to get at the weight, for instance. If we are determining the volume of a substance, then, supposing that this object were made of iron and we wanted to determine its weight (which is a very important and frequent calculation in bridge building and in all kinds of constructive work) his assertion amounts to the statement that we have to remember a constant anyway, and it is just as easy to use one as the other.

I want to dispute that assertion. I have possibly had more experience in matters of that kind than he has, and I thought that the committee might perhaps fail to consider the distinction between "factors." I want to call your attention to this fact: That in the metric system the factor by means of which you pass to the volume, to the weight, is the same thing as the factor by which you determine the specific gravity of the substance. It is not that factor multiplied by something else, as in the "inch" system; it is not a fraction of it, but it is the same thing. And whereas in the ordinary system, the present system, you would have to use an awkward fraction, in the case of iron it would be 0.278; in the metric system it is generally a whole figure. In the case of iron it would be 7.7, or somewhere between 7 and 8, according to the chemical composition of the iron. We have a whole figure instead of a decimal to remember, and that figure bears a definite relation to the specific gravity of the substance as compared with water. The moment we know, for instance, how much heavier iron is than water—that is to say, the relative "specific" weights of these substances (and almost any child could be taught them)—we have, at once, a means by which we can pass without any effort on the part of the memory, without any effort at calculation, from one to the other.

In the present system we have to remember three factors at least; one representing the weight per cubic foot, one representing the weight per cubic inch, and the third representing the weight as compared with water or the specific gravity. In the metric system we need only one, the third, and as it is exactly the same as in the English system, it is obvious that there is no mental burden involved in learning it.

This is a great advantage; and it is an advantage which I want to return to again as one of the things of great importance in our civilization. In this country we have made a record by the way in which we can utilize materials in producing machinery, in producing all kinds of saleable products. But we are not making the same records that other countries have made in regard to the "utilization of brain force," especially the conservation of it—the saving of needless waste of brain force. That is not, perhaps,

a very happy way of expressing it; but the meaning that I intend to suggest to the committee is that to the same extent that we endeavor to introduce improved methods of economy in the administration of business in saving labor and materials, we ought to introduce improved methods for the purpose of saving mental effort, mental energy. Every human being is limited in regard to the amount of mental energy that is available in him; and to the extent that we relieve him of all unnecessary tedium in the use of his brain, to that extent I think we tend to make him more useful to himself and more useful to the community.

The CHAIRMAN. Do you mean that the American, with our system, has to work harder to reach the same results?

Mr. MAILLOUX. He has to work harder to reach the same results, consciously or unconsciously. That is exactly the point which I want to make.

The point is often brought out against the metric system that it requires some effort to learn it and to remember it. That point, it seems to me, loses its force entirely when we stop to consider the difficulties in learning the present system and in remembering it. I want to say that in my experience of many years in varied lines of scientific and engineering work I have never found any person who had the English system of weights and measures at his fingers' ends. I venture to say there is not one of this committee, there is not one of the men who has appeared before this committee, that could offhand tell all the units of the present system, that could tell the difference in the number of grains between troy weight and avoirdupois weight. I know that I can not do it. I have to stop and study each time, because there is a complexity of factors, of multipliers, to remember that is certainly taxing; and I find it simpler to refer to a book whenever I wish to know them and be sure of them. I gave up long ago all hope of ever being able to depend on my memory. Indeed, I did not wish to tax it in this way.

For instance, although I have been an engineer and have had to do to some extent with surveying and with railroad work and with all kinds of engineering operations involving land measurement, I never know what the area of an acre is. It is very hard for me to remember it. With the metric system it is not necessary to remember it. It is either expressed in square meters or in square kilometers or in other units which are multiples or submultiples of the meter, and there is no effort involved. A person can pass from the one to the other without any difficulty at all.

The CHAIRMAN. I suppose it is somewhat analogous to our decimal system, our money system?

Mr. MAILLOUX. Absolutely.

The CHAIRMAN. When you know how many cents you have, you know how many dollars you have.

Mr. MAILLOUX. Exactly. It is no effort for us to say how much a certain sum of money amounts to in dollars, or how much it amounts to in mills. We pass from the one to the other by simply placing the decimal point at the proper place. The metric system is exactly analogous to this; it has that great advantage.

One of the great merits that has always been urged in favor of the existing or the so-called English system of weights and measures is

the point mentioned by another witness before this committee, Prof. John E. Sweet, who said:

. The fact that the divisions of each are in decimals possesses advantages in computations is evident—

There is something wrong there, but I am reading it as it appears here—

But this advantage is partly neutralized in the ordinary transactions of business because of the impossibility of overcoming the natural disposition of mankind to divide things in halves, quarters, etc., and more than overbalanced in the practical use of ordinary lineal measures, as there are many conveniences incident to the inch, the foot, and the 2-foot rule that no one has been able to produce and never can produce and follow the decimal subdivisions.

I want to submit that in this very résumé of the testimony contained in this same article there is an argument which refutes that, for Mr. McFarland, in his article in speaking of the facility of computation, says:

When we make a comparison between the simple metric weights and the complicated English ones of tons, hundredweights, and pounds, perhaps running down into ounces, the contrast is enormous.

So, you see, he admits the difficulties of the case. He goes on:

But, as a matter of fact, we have simplified matters a great deal, and in our own electrical work the units we use are the inch, its decimal multiples and submultiples, and the pound weights, decimal multiples, and submultiples.

So, you see, gentlemen, that notwithstanding the fancied great advantage of a system which admits of being divided into halves, quarters, eighths, and so on, by division by two, these people have been obliged to adopt a decimal system. They have been obliged to decimalize the inch and to decimalize the pound. In my work in the interests of my clients I have constant dealings with the Westinghouse Electric Company, the General Electric Company, and many other electric companies, because I am a practicing consulting electrical engineer, who has charge of many electrical plants and installations for clients, and have to buy machinery from them, and I have to make calculations which are submitted to them. I have to go over calculations which are submitted by them, and I have noted the fact that they have come to the use of the decimal inch and the decimal foot. So that therefore the great advantage which has always been urged of the subdivisibility of the unit by a system of 2 instead of by 5 or 10 is practically sacrificed. And why is it done? Simply because of the greater advantage gained by the facility with which a decimal system lends itself to computation.

Let us consider the metric system from the standpoint of the Government service. As I am not a statistician, I can not say exactly what effect it would have; but I can well imagine that in the Land Office, in the Patent Office, in the War Office, in the Navy Office, in the Bureau of Steam Navigation, and places of that kind, the greater facility of the decimal system logically carried out (especially a consistent decimal system such as is the metric system), would not only simplify the amount of work and thereby possibly enable a more or less important reduction in the force to be effected, but would make whatever work there still remained easier for all parties concerned.

I want to refer here to another very strong argument which is always urged against the adoption of the metric system. Mr. Macfarland says:

> It must be realized that any concern which has been in the manufacturing business for some time is under a moral obligation to furnish its customers with repair parts. This means that for a long time to come, even if the metric system were adopted; such a company as ours would be compelled to maintain a considerable portion of the works for this repair work, together with all the measuring appliances, drawings, patterns, etc. In the case of a new establishment just starting business, this question does not, of course, arise.

This argument may perhaps have some force in some cases; but I think that certainly it is not an argument that, to anyone familiar with the condition, the growth and the development of the electrical business, has any force whatever. The fact is that the electrical systems which are in use and for which machinery is being furnished by the electrical manufacturing concerns become obsolete so quickly that not only need there be no fears of being compelled to keep in readiness for furnishing repair parts, but in the great majority of instances in a very remarkably short space of time there is really no demand for them.

In discussing the matter recently before a number of professional engineers, the question of standardization of electrical apparatus being the topic under consideration, it seemed to be the consensus of opinion that it was possible to do more harm than good by attempting to standardize too soon and too much; and I myself pointed out the fact that it would be impossible to-day to go into the market and to buy electric machinery which was standard ten years ago or even less than ten years ago; the reason being that the march of progress, the development, has been so great, that these manufacturers would no longer furnish that machinery at any cost. It is "obsolete" in the most emphatic sense of the term.

The CHAIRMAN. And for repair purposes they would have to keep the tools anyhow?

Mr. MAILLOUX. No; because to-day in the great majority of cases not only is there no demand for repairs, but the old machines are being thrown away and "scrapped" and are being replaced by new machines as fast as possible.

The CHAIRMAN. I understand Mr. McFarland's argument to be this, that these machines are more or less in use, and repair parts are necessary from time to time?

Mr. MAILLOUX. Yes.

The CHAIRMAN. And that it would require the keeping of the tools in order to supply those repair parts.

Mr. MAILLOUX. I was talking about this very matter yesterday with a man connected with a large electrical company, and he spoke to me of a request which they had for furnishing a duplicate of a machine which was made something like ten years ago; and that was considered a solitary instance of demand which they had had to furnish parts or to furnish duplicates of a machine as old as ten years ago. That, it seems to me, gentlemen, completely meets the objection made on this score, for the reason that it shows clearly that if any such drawback as that exists it must exist to a very reduced and limited extent. It is not a serious difficulty. It is not at all what the text would evidently lead you to infer it might be, reading it without qualification.

An argument is mentioned here by Professor Sweet that railroads have been built by the English system of measuring distance (the time tables give the distance in both systems in Mexico) and that the gauge of the roads is 4 feet 8½ inches. That is another statement which ought to be qualified in justice to the metric system, because I think that there you find a strong argument in favor of the metric system. The statement is made that it does not lend itself to existing methods. Now, the railroad itself furnishes an instance of the manner in which American methods were used, adopted, without interfering with the metric system and without hurting anything at all. The Europeans adopted for the most part our gauge, the standard gauge, 4 feet 8½ inches. I think that this gauge was, as a matter of fact, the English gauge, which we ourselves adopted originally. In this country we admit that 4 feet 8½ inches is an awkward figure. We do not like it ourselves. And, as a matter of fact, even those who are more or less familiar with it are apt to forget at times whether it 4 feet 6½ or 4 feet 8½.

But however that may be, the Europeans, in adopting it, simply translated that 4 feet 8½ inches into millimeters, and they speak of a gauge of 1,435 millimeters or 1.435 meters, the difference being merely a question of placing the decimal point. They call it 1.435 meters or 1.400 meters, or whatever the gauge may be. In some cases they have departed a little bit, for various reasons, from our gauge. They have simply added or taken off a few millimeters; and in other cases they have used a gauge which corresponds to our 3-foot gauge as nearly as possible, only they made it 1 meter for the sake of having to deal with a round number. These are cases, evidently and obviously, as anyone can readily understand, where it would not make any difference which system was used in specific and special cases; whether we measured the machinery by one system or by the other; whether we had it made by one system or by the other does not make any difference. It is simply a question of individual and personal convenience in that specific case. I simply wish to cite that instance as a case where the adoption of an idea originally conceived, originally applied and utilized in terms of English or American units, has led to no difficulty whatever when used in countries where the metric system is in vogue.

The question of the change is always looked upon as a formidable one. I have already shown that in the case of electrical manufacturing, at least, that change is not going to be a formidable one, because the methods, the devices, the machinery change so much, become so quickly obsolete that, we may say, these companies are turning out new systems all the time. It is a fact, gentlemen, that all of these companies are all the time bringing out new designs, and that the designs of last year are already considered a little old, and that those of four and five years ago are considered in most cases quite old; and that, as I have just said, at the end of ten years they are obsolete.

In that case, at least, the change will not be a severe one, because it will necessarily be gradual; it can not be anything else. They would simply begin by doing the new work in the new system, of which they have some all the time; and they would allow the other to fall, naturally, into disuse by becoming obsolete, as it necessarily will in most cases.

Another fact which I want to point out is that, in the electrical industries at least, the metric system is already being used; and that it has been used as the result of convenience, as the result of the greater facility with which it lends itself to calculation, to computation, to design. All the electrical units—the ohm, the ampere, the volt—and I need not name all the others—are units which are based upon the metric system and expressed in terms of it.

When we come to the design of dynamos the important practical question of determining the amount of iron that will be required in the frame of a machine, the cross section that will have to be given to it in order that that metal may hold, so to speak, a certain amount of magnetism; that question has to be determined by reference to the quantity which we call the magnetic density—the amount of magnetic force, so to speak, which can be crowded in that iron per unit of cross section.

There is a well-defined unit for that—the "gauss," named from a distinguished German scientist—which was adopted in 1900 at the electrical congress in Paris. That unit, I am glad to say, gentlemen, was proposed and brought to recognition by the American electrical engineers. It was a unit which had been in use in this country for several years. It was recognized as being of distinct utility. It was consistently and generally used in the engineering office of every company where electrical machinery was designed. It was officially adopted as an international unit at Paris, and the fact that it was being used in America had much to do with its definite adoption by the other countries.

In some cases the attempt was made in this country to translate this unit into inch measures and to use it in that form. But as all the literature all over the world is expressed in terms of the metric unit it was soon found that this involved not only some difficulty—in other words, some mental work—but a possibility of mistakes, a possibility of error in the translation between one system and the other. For that reason to-day you will find in the literature, you will find in the catalogues or in the descriptive circulars sent out by the "publicity" departments of the various electric manufacturing companies that when they have occasion to speak of the magnetic density, either in the core of a transformer or in the core of a magnetic field of a machine or in the air gap, those densities are always expressed in terms of metric units, and every electrical engineer in this country understands those things far better when they are stated in those units than when they are stated in any other. In fact, I doubt very much if 5 per cent—if, at most, say, 10 per cent—of the electrical engineers in this country have any conception at all of the equivalent expressions in inch measurements. They convey no meaning to them, whereas if you say to any person in the electrical business that the magnetic density of a certain air gap or through a certain cross section of magnetic circuit is 5,000 gausses he knows absolutely, he knows at once just what is meant and understands it definitely.

So that, in this respect, you see, gentlemen, the system is already forcing its way. It is actually making its way. And in conversing about it with the younger men who have come out of school more recently I find a disposition to believe that the system is bound to be accepted, is bound to come. It is inevitable. The feeling that seems to be uppermost is that those who are past 40 years find it a little difficult to make themselves familiar with it. There is a certain

amount of mental inertia, a certain amount of indisposition on their part to go through the small amount of effort required to master the system. And for that reason they prefer to adhere, to stick to the evils which they already have rather than to trust themselves with things that they do not know or do not care to take the trouble to investigate.

The feeling, however, is very strong among the younger engineers of all branches of the engineering profession that the metric system is sure to be adopted in this country. I believe that there is an attempt being made in England now to decimalize the English system, in the hope that this may tend to reduce the demand which is being felt, even in conservative England, for the metric system, for the metric system there has its advocates, and the friends of the existing system are making quite some counter-agitation.

Recently, in the course of some correspondence, some one strove to utilize a statement of mine as indicating my favoring a decimal system, and that I would be satisfied with the inch system. The argument was made that, for instance, one of the advantages of the English ton of 2,240 pounds was its close approximation to the metric ton of 2,204.6 pounds, it being something like less than 1 per cent out of the way. In my reply I characterized this as being not an attenuating circumstance, but an exasperating circumstance. In my opinion, such attempts intensify the inherent defects of a counterfeit, or an imitation, which is objectionable to anybody who loves the real and the genuine, whether it be in art or science.

Finally, gentlemen, the one point above all others which I would like to urge upon you as a committee is one which I approach with some hesitation, because you may think that I have come here to lecture to you, for now I am going to speak of the question of the adoption of the metric system from a higher standpoint. I am going to speak of it not exactly, perhaps, from the moral standpoint, but at least from the altruistic standpoint.

Mr. WOOD. Before you go to that, may I ask whether there has been any agitation or demand in England for the supersession of the English standard and the adoption of the metric system?

Mr. MAILLOUX. Yes, sir; and the conservative men have formed an antimetric association.

Gentlemen, I want to mention now one or two other points which had escaped me in looking over my notes.

I said that the metric system is being used already; that it is forcing its way, even without any fostering care on the part of anybody, into the electrical industry. I want to point out the fact that it has already not only forced its way but it has completely mastered the situation in chemistry. I remember very well, when I was still almost a boy, hearing the statement made at a meeting of the polytechnic section of the American Institute of New York, at Cooper Union, that in twenty-five years there would be no American chemist that was not using the metric system. That prophecy has been verified; and I think that I could say that there has not been a chemist who has used anything else but the metric system in this country for at least ten years, and possibly for a longer period.

I want to point out that in civil engineering it has long since been found of absolute necessity to decimalize the foot and the inch. The civil engineer for thirty years and perhaps for a longer period has

not recognized the inch subdivided into eighths or twelfths, but has used the decimal subdivision. In his case the adoption of the metric system, while it would not be of as great benefit, would be still of great benefit because it would simplify his calculations; and it would have the great advantage that he could absorb it, appropriate it, utilize it, without any difficulty at all. It would only be a question of changing his instruments for linear measurement, which are not expensive. His theodolite and his transit instruments would remain the same; and I will not refer to the argument made in favor of the bridge builder, which has already been dwelt upon sufficiently by others before the committee.

Finally I come to the important point which, as I have said before, I approach with some hesitancy. I want to take the position before this committee that the passage of this bill or some similar bill should be regarded by the committee and should be regarded by Congress in the light of a duty. As legislators you would not hesitate, and you do not hesitate to take any measures, whether it be in the reform of the tariff or the reform of railway rates, which you think are calculated to be of the greatest good to the greatest number. In this case it seems to me that there is very much more involved than the mere question whether a few companies are going to be put, temporarily, to a little inconvenience or even to a little expense in making this change. There is involved the great and important question not only of the great permanent ultimate benefit to us as individuals and as a country, but there is involved the important point that you can not do anything better for the well-being of the country than to adopt any measure which tends to decrease the amount of mental effort that is necessary for us as citizens in pursuing our avocations. Anything that tends to lighten a man's intellectual burdens, whether it be in one form or another, whether you do it by voting him subsidies or whether you do it by giving him a nerve tonic or in any other manner is certainly a boon; it is a blessing; it is something to be desired.

If you can simplify the problems of education in the first place or reduce the mental wear and tear of education, and if, in the second place, you can reduce the mental wear and tear incidental to the daily pursuit of the man's vocation or of his profession you are doing something which not only affects one individual, not only affects one interest, one part of the community, but you are doing something which affects, either directly or indirectly, every citizen in this country as well as every citizen in the world. For, I maintain and I can prove, gentlemen—it would take me, perhaps, a little more time than you would care to give and it is perhaps unnecessary—that the adoption of a system like the metric system is so far-reaching that it ramifies clear into the household, and that it is a thing which is calculated to benefit the human individual, the unit of the population, almost from the time that he can speak.

I think, gentlemen, that when a measure is involved that is of such importance to the welfare of the community as this I am entitled to say that it is the duty of this committee to consider it seriously and to recommend the adoption of the bill even if it were only capable of doing a fractional part of what I say and what I believe it can do.

I thank you, gentlemen.

The CHAIRMAN. We are much obliged to you.

Now, this is one of the things that has appealed to me. I have not given this subject very much attention, but I have read now and then about it. I have listened to what has been given before this committee, and it strikes me in this way, that there is not a country in the world where they do not have a decimal system—you may take it in England, in Canada, or anywhere else—where there is not a constant agitation, a steady tendency toward a decimal system, and the only decimal system that has any chance in the world of becoming universal is the French metric system. There is not a nation in the world—there is not a country in the world where they have a decimal system established where they would tolerate for a moment a suggestion to change from the decimal system; not one. You can not find one. The tendency always and everywhere is toward a decimal system, and there is nobody to-day, so far as I know, who would stand up and say that a universal system is not a thing greatly to be desired. Almost every witness who has come before this committee who has given the subject any attention has said that he believes that if we adopt it it is only a question of a very short time before England will adopt it. If they should adopt it it is only a question of a very short time before we should certainly adopt it.

Mr. MAILLOUX. Could I say a word about England?

The CHAIRMAN. Yes.

Mr. MAILLOUX. I would like to add, gentlemen, apropos of the question of the agitation in regard to this system in England, that I happen to be personally very well acquainted with many of the leading scientific men there, being myself a member of the Institution of Electrical Engineers, and having visited England several times and had occasion to meet them, especially during the year 1900, at which time I was one of the official delegates from this country to the meetings which were held in London and in Paris. I have had repeated occasion to discuss this matter with English engineers and with English scientific men, and I have found that there also no educated man under 40 or even under 50—I think even under 60—is in favor of anything else but the unqualified adoption of the metric system. And many of them, English and conservative as they are, go so far as to speak with impatience of the existing system.

I want to add, in reference to the decimalization of the existing system, that unfortunately for those who favor such a procedure, it has its limitations, which become so serious that they are compelled to stop short of it when they reach certain branches. Take, for instance, the decimalization of the pound. No one has undertaken to decimalize it beyond the tenth of a pound. So you see that when we come to the drug store, when we come to the chemist's laboratory, we have to stop there, because there are no smaller units of tenths, and nobody has suggested making any. So that there they are compelled to fall back upon the old complicated system, the absurb system which starts with grains, from which are made scruples, from which are made drams, and from which are made ounces. And you find yourself confronted with two such systems, two kinds of units, one in which 20 grains make the dram, and the other in which 24 grains make a dram, just the same as you have two kinds of quarts.

These things constitute, in my opinion, very serious fundamental and fatal obstacles to the improvement of the present system to such

an extent as to make it endurable for such purposes. I consider the point is well taken that when such a system as that can be made to present advantages which are similar to or which approach those of the metric system, it is nothing more than a confession on the part of those who propose and suggest and favor such changes that their system is weak, and that they recognize the merits of the metric system. And every time that they propose something which is near it and a substitute for it, I myself feel like becoming impatient, and saying "If we are going to make a change, let us make a complete change, one which is consistent from the beginning to the end, and one which does not involve any necessity for any of those tedious conversions by means of the multiplier."

Let us have a system wherein, as I have pointed out in the beginning of my remarks in connection with measures of weight, the relation between the volume and the weight is exactly the same thing as the relation between the specific gravity of water and the specific gravity of the corresponding substances—let us have a system which is so simple that you do not have to remember anything, you do not have to load your memory with a lot of abstract factors, or carry a memorandum book full of mathematical tables and factors with you if you wish to make use of these things. It is so much simpler to let everyone remember those few simple fundamental principles by means of which one can readily pass from any one of the measures to any one of the others.

Finally, in closing, I want to speak of one striking instance where the metric system shows its superiority—in the case of linear measurements or distance; measurements, for instance, as we are familiar with them in railroads. On the Continent you will find along the railroad track signs which indicate the change in grades; and when you come to one you will find it is "1:1,000" or "2:1,000," which mean one per thousand or two per thousand, according to the case. It simply means one meter per thousand of rise or fall, the rise being indicated by a board slanting up, and the fall by a board slanting down. In England you will find that system indicated by "1 in 52" or "1 in 46;" and you have to go to work and perform a mental computation to find out how many feet that amounts to per mile. With the metric system it tells at once whether the rise or fall is a meter per kilometer, or whether it is a decimeter per hundred meters, or whether it is a centimeter for each. It has the same relation throughout.

In our present system every civil engineer, every railroad engineer always has to remember that there are 5,280 feet in a mile; and when he comes to express percentages of a grade he always has to perform a mental computation in which a division or a multiplication by 5,280 is involved. If he were using the metric system he would have nothing of that kind to do. He simply sees the figure before him and he points off a decimal, just the same as when he is dealing with ten times $1.50 or ten times $1.53; it is a perfectly simple matter.

And while you may not realize it, every human being at some time or other—some of us very often, who are concerned with scientific work and calculation, laying out plans for men to carry out, others perhaps not so much concerned with them, but everybody to some extent—is confronted at some time or other with the necessity of

making calculations, and these things all involve the expenditure of mental force and mental energy; and to the extent that we can reduce that mental wear and tear to that extent we are doing something to make mankind happier and to make life easier.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Thursday, March 22, 1906.

The committee met at 10.30 o'clock a. m., Hon. James H. Southard in the chair.

The CHAIRMAN. We have asked Mr. Littauer, the author of the bill pending before the committee, to appear here this morning to say a few words, at least, as to what he thinks about the bill.

STATEMENT OF HON. LUCIUS N. LITTAUER, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW YORK.

Mr. Chairman and gentlemen of the committee, I do not purpose to make any long statement here this morning, but it seemed to me that we had now arrived at that time in this session when, if it was desirable at all to report this bill to the House, in order that it may have a full and fair hearing before the House, we had reached the day when action ought to be taken.

The bill, as you know, is very simple. It contains but two propositions. One is to make the use of the metric system compulsory on the Departments of the Government, and the other fixes the date at which this compulsory use shall take place as July 1, 1908.

You probably know, from your correspondence, that people all around the country believe the object of this bill is to make the use of the metric system compulsory throughout the United States. It has no such direct object whatever. It is very plainly stated here that no one will be compelled to use the metric system of weights and measures unless he has dealings with the Government; there is no obligation whatever upon any private individual to use the system unless he so desires. I want to be perfectly frank, however, and I will state right here that the only object in making it compulsory upon the Government is that the people throughout the United States may begin to get some practical experience, or have examples before them, of the practical uses of the metric system of weights and measures, in order that at some future day they may be able to determine whether or not they will demand their compulsory use throughout the country. Any change, particularly in a country like ours, must come only from a long experience. And then, again, the people do not quickly become accustomed to new words.

It was years before our people became accustomed to the use of our decimal monetary system after that became law. I can remember that in my younger days in New England they talked about shillings. I remember the first time I went to Cambridge and went into a dry-goods store to buy something they gave me the price in shillings. It was almost the third of a century after the decimal system of money was adopted by the United States before it was generally adopted in the small transactions throughout the country.

The reason that I have taken an interest in the metric system since I came to Congress is simply this: As a business man in the workings of my own business I had learned to appreciate the merits that were contained in that system. I manufacture gloves. I have gone into various branches of work collateral to the manufacture of gloves; I have manufactured knitted linings that go into the lining of gloves; we manufacture metal fasteners that go on the gloves; we manufacture sewing machines, and in all these transactions into which my practical experience enters I have become absolutely convinced that the decimal system is the system that makes work exact, makes it ready of comprehension, and gives every facility in mental calculation. It enables one to do in his mind what ordinarily a man would have to resort to pencil and paper to figure out.

This metric system has really, to my mind, three points in its favor. In the first place, it is an international system. It does not make any difference what system is international. If the system is the established system, it has advantages that every one must recognize. Bear in mind that it has been adopted by pretty nearly every government in every civilized part of the world with the exception of England and ourselves. I believe there are 500,000,000 people to-day who use this language. And then again, this corelation between its parts has appealed to me, not from my own uses, because I have not in my own work had to do many calculations in that way, but it is so simple that it appeals to one from the standpoint of simplicity. Men of science have adopted it as the standard of their calculations on account of its simplicity. When it comes to the decimal end of it, it seems to me that it ought to be adopted simply because it is decimal. In my glove business I have taken it up from a practical standpoint, have adopted it, and found it works to my advantage.

Mr. WOOD. Do you not think it appeals more to scientific men than to practical men?

Mr. LITTAUER. In the corelation of its parts I think it does.

Mr. WOOD. I have received a great many letters from manufacturers opposing the bill, who say that it would involve a great expense and annoyance to them if they were compelled to use the metric system, and what I want to know is what is the answer to that position taken by the manufacturers, if there is any answer?

Mr. LITTAUER. The manufacturers of what?

Mr. WOOD. Rubber manufacturers and all sorts of manufacturers.

Mr. HARDWICK. Tool manufacturers?

Mr. LITTAUER. The tool manufacturers in particular, I believe, are the ones that have this bugaboo before them. If they in the first place——

Mr. WOOD. I have received from the Association of New Jersey Manufacturers letters stating that they had no idea that there was any prospect of this bill passing, and that if they had known there was such a prospect there would have been a great avalanche of protest. What it seems to me is that if they would not be put to any expense or annoyance there ought to be at least a campaign of education first before any such radical legislation, even as this bill provides, is passed by Congress.

Mr. HARDWICK. And in connection with Mr. Wood's question I will say this: The secretary of the National Association of Manufac-

turers writes me to the same effect, that his association, by formal and official action, is on record against the metric system, and that they are all opposed to it, even after having it explained to them that it is not compulsory and only applies to the departments of the Government.

Mr. WOOD. And I also want to say that Mr. Taylor, who appeared here at the last meeting of this committee, is a gentleman who has had much experience in manufacturing, having been with the Midvale Steel Company and the York Lock Works and other manufacturing establishments, and that he spoke from a practical standpoint. He said it would be objected to by the workmen, and that it would be a most unpopular thing. He went on to say that the present measurements of the United States standard are their assets—one-half, one-quarter, one-eighth, one-sixteenth, one thirty-second, and so on—and he expressed himself very vigorously upon this subject. Now, I, for one, as a practical man, would like to know from you as to the real situation, as to whether these views are correct views; whether the manufacturers of the country would be put to a great deal of expense.

Mr. LITTAUER. Let me answer the two points as I have apprehended them. First, that there is a sort of propaganda of opposition around about, that comes from secretaries of associations, and so on. Referring to the manufacturers' association, I was a member of that association, and I found out that they are very much—well, we have had the same experience in political life—that a petition can be gotten up for almost anything. I found that this manufacturers' association was really a little coterie of two or three men, and that many of its resolutions went forth without any fair proportion of its members having opportunity of voting or expressing themselves upon the resolutions.

The CHAIRMAN. You found that in 1898 they indorsed the metric system very vigorously?

Mr. LITTAUER. Yes.

Mr. HARDWICK. One further point. Did they have a discussion of this matter before offering these resolutions; was there any fight, or do you know about it?

Mr. LITTAUER. I don't know about that, but I do know that the manufacturers' association under the lead of Mr. Cushing, and led largely, I believe, by one or two other gentlemen who appeared here, are the active opponents of the metric idea throughout the country and have been so for a number of years. They have instigated the resolutions passed against it. I don't know what a quorum of that association is, but I presume probably three would enable them to pass resolutions. I was formerly a member of the association and resigned because I did not like the way it was run.

Mr. HARDWICK. I think some of them are writing to different men in our districts asking them to write to us against the system.

Mr. LITTAUER. I am getting letters every day.

Mr. WOOD. Should not that be taken as the opposition of the manufacturers' association until you have some proof to the contrary?

Mr. LITTAUER. Yes; let us take that as the opposition of the manufacturers' association, let us say that; but the mere fact that the system is opposed is one thing and reasons given for the opposition is another thing. I feel that if they came here with valid reasons

we would have to meet them, and if we can not meet them then we will have to "lay down."

Mr. LILLEY. I would like to ask you whether it is a fact that if this is adopted mechanics generally will be required to purchase, at considerable expense, new sets of tools?

The CHAIRMAN. No; it is not true.

Mr. LITTAUER. I do not believe that this bill would affect them. Let us take it up only as far as this bill goes, because if this bill should be enacted into law any further progress to be made would take five, or ten, or twenty-five years, or it might never come, depending on the experience under the bill. Only such manufacturers as dealt with the Government, in the first place, would be called upon to make any changes whatever——

Mr. LILLEY. I understand that this is to be the entering wedge?

Mr. LITTAUER. Yes; it is meant to be. I hope that it will be the entering wedge toward the adoption of the system generally, but the entering wedge does not always drive the thing home or split the thing apart.

Mr. LILLEY. But when you get things started you don't know how far you are going, and it is on this ground they object.

Mr. LITTAUER. Yes.

Mr. WOOD. At the present time the Departments have the privilege of using the metric system. What is in the way of their using it to any extent that might be advisable? Why is it necessary that it be made compulsory on the Departments of the United States Government if they already have that right?

Mr. LITTAUER. There is the right throughout the country——

Mr. SCROGGY. I think it is fair to Mr. Littauer to let him answer one question at a time. I would like to hear first the answer to the question about the additional expense that would be incident to the change of tools made necessary by the passage of this bill.

Mr. LITTAUER. The biggest objection, and the objection that bears on the whole change, is that in tool making and in matters connected with machinery it will involve great expense. There are certain scales that have become arbitrary. For instance, screws of a small size are known at No. 1, No. 2, No. 3, or No. 4; they are not known by sixteenths or eighths, and you go into a store and buy a No. 2 screw or No. 3 screw. Now, that can remain a No. 2 screw or No. 3 screw as well under the metric system as under the present system. Another thing is that they claim that the change from the one to the other is very radical. I had a manufacturer of plows write to me the other day that his bolts are one-sixteenth and that if the metric system were adopted the Government in their specification of plows for the Indian Service would have to write to him for bolts 26.984 of a millimeter. What an utterly ridiculous proposition! What is 0.984 of a millimeter? Is there any bolt made on which a finer measurement than one-sixteenth of an inch would have to be used, especially the kind of nuts and bolts that go into a plow? They make a bugaboo out of the thing. The expense that would be incurred would be that if they were dealing with the Government they would have to have measures on one side of the rule, for instance, that would show the meters and decimeters and millimeters, and on the other side of the rule would be the ordinary measures as they now are.

Then, again, machinery is not made upon specifications, as a rule. For instance, I am a manufacturer of sewing machines.

If I desire to buy a milling machine or anything like that, I have the pattern of the machine that Brown-Sharp have specified tools for making, and that machine is on the market, and I buy their milling machine known as such and such a machine, as A, B, or C, or something of that kind. I believe in nine-tenths of the operations in the manufacture of machinery there would be no change at all needed. For instance, take a Wheeler & Wilson sewing machine needed in the manufacture of clothing for the Army. They would specify a sewing machine to do a certain character of work and they would buy the patterns in existence, owned by the Wheeler & Wilson Company. Then again, if these people dealt largely with the Government they would buy, for instance, a tool to work on a gun in the gun factory. They would go to the Midvale company or some of these people who do certain kinds of work and they would buy that tool, or specify for material—for steel with a certain bore to it or a certain diameter, and they would specify in millimeters or whatever it may be, and those decimal divisions of the metric system are so exact, and the present system of inches and thousandths of an inch can be so easily converted into the other, and the nicety of measurement under the metric system would be so great that not one time in fifty in my opinion would they ever have to change anything in filling the orders and their deliveries.

Mr. WOOD. It would be easy enough for the draftsman probably, and the higher officers of the concern; but it is said that it would not be such an easy matter for the workmen.

Mr. LITTAUER. Take a workman, or take you or myself, and let us put ourselves in the position of a workman in a division of employment that now goes on. It is a certain character of work; the workman does not have to go into the calculations that draftsmen have to go into, but he simply does a certain piece of work. He has been accustomed to deal with feet, or pounds, and all he has to learn is the simple part of the metric system that interchanges with what he has been accustomed to work. He hasn't got to learn any great big complication, he does not correlate one part with another.

Mr. WOOD. Instead of seven-eighths of an inch he would have a lot of decimal figures.

Mr. LITTAUER. He would have a decimal figure that would come so close to it that his mind would grasp it right away. We appreciate the inch or the quarter of an inch, but none of us appreciates the thirty-second or the sixty-fourth of an inch, and to my mind we are coming back to one thing, and that is that decimal comprehension is the easiest and the most exact.

Mr. LOVERING. That is prefectly true, if we had been born with that comprehension, but we have been born with another comprehension and into another state of being. Now, I want to ask you a question, if I may. Suppose I take a contract to deliver to the quartermaster of the War Department 500,000 yards of drills or cotton cloth, whatever you please. I have done both at different times. My measuring machines in my mill are the yard, and quarter of a yard, and half yard. Now, suppose they take it into their heads to order the equivalent of 500,000 yards in meters, and it must be stamped on each bolt or piece what those meters are. Now, it is not

only that I have got to change that measuring machine so that it shall measure meters, but they also give me another condition, which is weight—that is, that the cloth shall be 2.73 yards to the pound. I have my measuring machines adapted to that sort of thing. Now, will you tell me how I am going to get along without getting new machinery?

Mr. LITTAUER. If the scale on your machine is by yards, that scale must be changed to meters. You have seen rules with the metric system on one side and——

Mr. LOVERING. No; this measuring machine goes this way [indicating].

Mr. LITTAUER. By yards?

Mr. LOVERING. Yes; I have to make it 39 and a fraction inches—I have to lenghten that.

Mr. LITTAUER. Yes; but the Government surely does not say to you that you must put so many yards in one piece?

Mr. LOVERING. Yes; they do say that.

Mr. LITTAUER. Then you would have to get a machine that was adapted to folding over in meters or else you would have to make the calculation, if the Government requires so many meters in each piece, and that means so many of these folds. There would be an expense attached to that.

Mr. LOVERING. The only point I make is this: I believe myself in the principle of the metric system, but the point is how to reach it without making too much expense to the people.

Mr. LITTAUER. True.

Mr. LOVERING. That is one step in the education that I want to know about.

Mr. LITTAUER. Now, you understand that this thing can not be picked up without some expense——

Mr. LOVERING. I have to make that machine in some way, and then I have to change my measurements—my weighing apparatus——

Mr. LITTAUER. There is not very much there to do. You have a piece the size of that, so it weighs so much in order to come within the Government standard. All you have to do is to reduce that on your metric scale.

Mr. LOVERING. That goes back. I have to organize a piece of cloth. It means my going back to the first operation with the cotton——

Mr. LITTAUER. There I do not agree with you——

Mr. LOVERING. You do not understand me. I say in organizing a piece of cloth I have to go back to my rule and beyond that, even to my drawings, and that necessitates the use of the English system both in measurements and in weights.

Mr. LITTAUER. Is it not a fact that you get a certain strain and you get a certain thread and you get a cloth that weighs so much?

Mr. LOVERING. And you can not go in and buy yarn unless you buy it by the numbers——

Mr. LITTAUER. And those numbers can be used just as well in the metric system as in any other system.

Mr. LOVERING. How do they reach those numbers?

Mr. LITTAUER. It is an arbitrary thing.

Mr. LOVERING. No; I beg your pardon. When you say No. 13 yarn it means something. It means hanks to the pound.

Mr. LITTAUER. How near does it come to it?

Mr. LOVERING. It is the most exact part of it.

Mr. LITTAUER. Then let us say it is 13 hanks to the pound. Then it would be 13 hanks to the equivalent of the pound in the metric system. It could not be anything else. Of course you have got to have metric measures also to measure in the metric way, and those measures will be different from the present measures, but how long will it take the men in your employ to become accustomed to simply figure out how long this measuring machine must be or how great this fold must be?

Mr. LOVERING. You do not understand me. This is the exact situation: I have these measuring machines that measure for me so many inches—39+ inches. That is for the quartermaster of the War Department. Then along comes Claflin, of New York, and he wants the other measure—the yard. I have to give them the yard.

The CHAIRMAN. I would like to ask the witness a question. Under this bill, supposing the Government should order 40,000 meters of cloth, would there be any difficulty in a manufacturer supplying the Government with 40,000 meters of cloth without changing a single measure?

Mr. LITTAUER. All he would have to do would be to determine that it took so many yards to make so many meters, and when he once gave that statement to a man using the old machine the man would immediately say—let us say that it takes 10 per cent less in meters than in yards—that in order to get 50 meters he would have to take off 55 yards.

The CHAIRMAN. In other words, it is simply a matter of translation?

Mr. LITTAUER. Yes; a matter of translation. But in the end this measuring machine you have I think would have to be changed.

Mr. LILLEY. Just go with me a little further along this line, because it is very interesting to me. A practical machinist must have a pair of calipers that will register about a thousandth of an inch. Now, that man must certainly get another pair of calipers.

The CHAIRMAN. You mean the measuring caliper?

Mr. LITTAUER. The caliper is a thing that moves to and fro; and all he has to have is the scale that registers down at the bottom one way or the other.

Mr. LILLEY. How far will that extend with all his other tools? It seems to me we have come to a point where there must be a change. You can not figure that out by taking 10 per cent or figuring 10 per cent, but there has to be a change somewhere.

Mr. LITTAUER. Let us see. Have you ever used a pair of calipers?

Mr. LILLEY. Yes; I was a blacksmith at one time.

Mr. LITTAUER. Did you use them often, even then?

Mr. LILLEY. Yes.

Mr. LITTAUER. I think that in the transactions that go on in the United States the necessity for any change whatever would not amount to more than one and a half millions, and we are surely not going to bring about this change without some expense; we are not going to bring about this change without people having to learn something.

Mr. HARDWICK. On what do you base your opinion?

Mr. LITTAUER. On experience.

Mr. HARDWICK. Let us estimate. Have you had any experience in anything except the glove business?

Mr. LITTAUER. Yes.

Mr. HARDWICK. I mean practical experience?

Mr. LITTAUER. Yes; I have manufactured knitted cloths and fabrics, and machinery.

Mr. HARDWICK. There are a great many lines you have not had practical experience in?

Mr. LITTAUER. Oh, yes.

Mr. HARDWICK. Do you base that on your idea of the lines you have been in?

Mr. LITTAUER. Yes; my observations carry me through. I have been a fairly observant man and have been thrown in quite a number of different fields.

Mr. WOOD. Are you familiar with the line of business represented by Mr. Lovering?

Mr. LITTAUER. Fairly so; not well, but fairly.

Mr. LOVERING. Are you familiar with the organization of cotton cloth?

Mr. LITTAUER. No; I can not say I am.

Mr. LOVERING. So many threads to the inch of such a number?

Mr. LITTAUER. Yes; so many threads——

Mr. LOVERING. What does that mean to you when you say it is 42 spuare of No. 14; what does that mean?

Mr. LITTAUER. That gives me a mental impression.

Mr. LOVERING. If I say to you, "Give me a piece of cloth 68 by 72 and of No. 60 yarn," can you tell me what that will weigh?

Mr. LITTAUER. I personally can not, but I know those familiar with it can figure it out. I have never had that experience, but why could you not do that same thing in the metric system?

Mr. LOVERING. You could.

Mr. LITTAUER. You could do it just as readily and just as easily.

Mr. WOOD. I want to ask Mr. Lovering a question through you. If he was receiving an order from the Government for cloth, and if it entailed additional expense, whether he would be likely to bid on it because of that additional expense made necessary by the change of machines?

Mr. LOVERING. In all probability the man who did meet the Government in its specifications would get the order and I would not.

Mr. LITTAUER. Now, I want to tell you the contractor who believes he can make $10,000, say, on a contract would be willing to spend 50 cents or a dollar to determine about this.

Mr. LOVERING. But suppose he doesn't know whether he is going to make a dollar?

Mr. LITTAUER. Then he will let the contract go. All he has to do is to pay out a little to make the calculations.

Mr. WOOD. In some cases you would not bid, then?

Mr. LOVERING. I don't know.

Mr. LITTAUER. Just think of that proposition. Here is a manufacturer about to enter into a contract with the Government. He believes he can make money or else he would not enter into it. He says there might be some trouble, as he does not understand this metric system. It will probably cost him a dollar or two to go somewhere and figure this out, so as to have exact data.

Mr. HEDGE. I understood you just now, in answer to Mr. Wood, to mean that the difference in the system of measure would govern you in making a bid?

Mr. LOVERING. They order so many drills, saying so many yards to the pound, and they say it must be so many threads to the inch in the warp, so many threads in the filling, and it must be of such numbers of yarns, it must be such breaking strain, and all that is expressed now in the English system. Now, to go and give that order to me to make so many meters of cloth, 100,000 meters of cloth with so many threads to the millimeter, or whatever you please, and so many—I haven't got hold of the metric terms myself, so I can not talk in them, although I believe in the language—they have got to give their specifications in entirely different words. Then they won't say that they must be made of 14 yarn one way and 15 yarn another; they will say it must be made of yarn weighing so many fractions.

Mr. LITTAUER. I believe that the custom of numbering these yarns will remain practically the same.

Mr. LOVERING. They will always be by the pound.

Mr. LITTAUER. The size of the yarn is known as No. 14.

Mr. LOVERING. What does it mean?

Mr. LITTAUER. You said 14 hanks to the pound.

Mr. LOVERING. A hank is 840 yards.

Mr. LITTAUER. And that will soon be reduced, you understand, into a metric length.

Mr. LOVERING. You won't have 14, I know, then. If you say 14 then, it won't be 14 now. If you say 60 then, it won't be 60. It means 60 hanks of 840 weighing 1 pound.

Mr. LITTAUER. In countries that have adopted the metric system don't they number their yarns?

Mr. LOVERING. Yes.

Mr. LITTAUER. It is a sort of a world nomenclature.

Mr. LOVERING. If I could get the whole world to adopt it, I would be in favor of adopting it, but to say that we are going there by any such measure as this which forces the Government in dealing with me to put conditions on me that are impracticable or difficult to perform does not seem reasonable.

Mr. LITTAUER. I don't think they are impracticable; they may be difficult. In other words, you will have to have some calculations with it, but how are you going to bring it about unless you bring before the people its advantages as well as its disadvantages? There are disadvantages in making a change of weights and measures, but think of the disadvantages we are having to-day, think of the disadvantages in determining pounds and bushels and barrels and all such things that are going on to-day, and then, again, think how easily we can overcome in the enormous foreign trade we now have and which is growing, how easily we can overcome these difficulties you are referring to. I feel that the benefits of the system, the benefits based alone on the simple idea of decimal notation, which means simplicity, which means ease of comprehension, which reduces a great lot of diversified weights and measures into a few simple ones, far outweigh the disadvantages. In fact, there are only three weights and measures that it is necessary to learn. I believe that so far counterbalances any disadvantages that may come—and there will necessarily be disadvantages—that it is to my

mind one of the greatest benefits that could come to this practical nation, to adopt a system which is so easily comprehensible and so acted upon. We did change from pounds and shillings and pence to dollars and cents, and see the advantages we have from that change; see the advantages our bankers have in the calculation of interest, we will say, as against the Englishman.

Mr. LOVERING. There is no disputing that.

Mr. LITTAUER. And see those great advantages that come. Do not the advantages of this system counterbalance the disadvantages by at least a hundred or five hundred times in the ordinary transactions in life of the 80,000,000 people of this country? Seventy million of them would learn the metric measures, such measures as they would need to use, probably within a day or two. They have been adopted by countries whose average intelligence is far beneath ours and they have been found useful there; the people have become accustomed to them. This statement here that the metric system is not used by those who have adopted it is ridiculous.

Mr. WOOD. Is it used universally in Germany?

Mr. LITTAUER. It is not used universally anywhere and it will not be used universally anywhere, but it will be used in 95 or 98 per cent of all transactions. We have to realize that there is some expense; we have to realize that there are certain contingencies in which this system will not be generally used; but here we have before us from the practical standpoint of everyday life—and that is what I am talking about—the great saving and convenience this system will be. The scientific men have already determined that they must necessarily use the metric system, because they have to compare their work with the other work that other people over the world are carrying on. Engineers are now figuring in the metric system. They use it because it is so much more exact and convenient. Everything is decimal, and it can be strung out, and calculations are simple in it and are so self-evident that mistakes are corrected easily, and to my mind it is going to lead to an exactness in weights and measures that will prove an incalculable saving to the people; they will get what they buy. They will buy more exactly what they want; there will be less weight; it is a nicer determination, and can be used to advantage in the small transactions of life.

I am going to revert to my own business again, because that appeals to me more than anything else. I came to Congress nearly ten years ago now. We had here a very lovely old character, Dennis Hurley, from Brooklyn. He was a man who had represented Brooklyn many years, and had been a weigher and gauger down on the wharves in New York, engaged in weighing and measuring articles brought in in foreign commerce. He became so impressed with the metric system that it was the one object of his life to carry it through, and when the old gentleman here just before his death felt that he had not long to live, he said: "Now, see here, I have been trying to bring this about, and I leave you the legacy of following this thing up." He was a man of no great education, but of splendid character, and he felt he could do much to aid the commerce of the United States, to aid the comprehension of ordinary people in their estimate of weights and measures, if he could only bring about the beginning of the adoption of the metric system so that the common individual

or the ordinary man would have an opportunity of getting some little experience in his dealings with the Government, that he begged of me to continue this work, and he said, "You can do nothing greater or accomplish anything more than to carry on this work." I believe that from my own experience.

Now to revert to my own practical experience. I remember we used to buy skins by the dozen; we used to cut them into dozens of gloves; a dozen skins would cut so many dozen gloves and so many pairs, which again are twelfths. Our calculations always required a pencil and paper. We pretty soon found that the Germans, who were outstripping us in the glove business, were buying and selling their skins by the hundreds or by the tens, and that they were cutting them and figuring them 2.25 or 3.33 pairs, and their calculations were so easy that every one about the factory could practically determine without any pencil or paper, but simply by mental arithmetic, how anything he had before him would figure out. I adopted the system in my factory. At first they kicked, but after the first week you could not get a single one of those men to go back to the old way. The decimal system appealed to them so that they think decimally now, and we do not have any work at all now in calculations of making cost, and so on, as we used to. Our system of money is the one thing that must appeal to everybody. If there was no other advantage at all in the metric system except that it was a decimal system, I should say that it was incumbent upon Congress to give the people of the United States a chance to adopt the metric system. Now, this committee here has for many years carried on hearings, and I believe you have heard more from scientific men, as a rule, than you have from practical men.

The CHAIRMAN. I think not.

Mr. LITTAUER. The average practical man continues along the same course he has been going and does not bother very much as to changes, but the scientific men have appealed to you on one side and the other side of this question; the majority of scientific men are in fields requiring nice calculations, and all over the world they have adopted the metric system, and it seems to me the time has come when this committee should give the House an opportunity of determining whether or not they want to take this step in advance.

When I first came to Congress we lost this bill simply because a few gentlemen made fun on the floor of the House of the metric nomenclature—that is, milligrams and decigrams, and so on. It was very well done and it was defeated on that account. It was lost because it was so cleverly done.

The CHAIRMAN. It was lost by one vote.

Mr. LOVERING. Do you mean it was well done or adroitly done?

Mr. LITTAUER. Well, adroitly done; from his standpoint it was well done. You can sit here day after day, but you can not get away from a few simple facts, and one of them is that the majority of the people of the world are coming to the metric system. Five hundred million people to-day are using this system. Only such stubborn nations as the English, for instance, who still maintain their pound, shillings, and pence for their own advantage, are keeping us from the metric system, and when they come to deal with their colonial dependencies we find one of their premiers quite recently demanding the adoption of the metric system. We, the most practical nation on earth, with

our increasing commerce, with the necessity of having thousands of clerks constantly figuring from the metric system to our system and back again, ought to have a fair chance to see the practical workings of this law; and remember it is subject at any time to being discarded if difficulties arise such as can not be overcome, if our experience is such; but there is a great big body of men in this country who believe that we can save millions and millions of dollars by its adoption, against the petty expense that may be cause by the change in weights and measures.

Mr. LOVERING. Will you state where we are going to save the millions of dollars?

Mr. HEDGE. Where do you save any appreciable amount from your change in measuring you spoke of just now?

Mr. LITTAUER. I have in my little factory in Gloversville six less clerks.

Mr. HEDGE. On account of that?

Mr. LITTAUER. Absolutely; there has been no other change.

Mr. WOOD. Is it not a fact that the great mass of the testimony in these hearings has been in opposition to the metric system?

Mr. LITTAUER. I do not know, but I hardly think that is so. I have not been on this committee for six years, but I do not believe that is so; if it is so I do not think you have heard from very many——

Mr. WOOD. We have not heard from the right men, you mean?

Mr. LITTAUER. I do not know about that.

The CHAIRMAN. During last Congress we had some hearings on this bill or a bill almost like it. Every man save one who came before the committee came in response to a request from certain members of the manufacturers' association who appeared to oppose the bill. We requested nobody to appear who pretended to favor the legislation except one—one gentleman from the Navy Department. At this session of Congress some of those who favor the legislation requested an opportunity to appear, and we have been trying to give them that opportunity, and I want to say right here that almost all of those who have appeared—and they have all been manufacturers or members of the association of mechanical engineers, so far as I recollect—base their objection upon the alleged fact that the adoption of this bill by the Government will result in large increase in the cost of conducting their business by reason of the fact that it will displace a lot of small tools which they use in manufacturing. Before these hearings close if I have the opportunity I am going to try and demonstrate right from the testimony of these witnesses themselves that what they say in that respect would be an impossibility.

Mr. LITTAUER. To what the chairman has stated I want to add this: You notice how the New York Herald has taken up the adoption of the metric system. They have presented in their columns during the last three months statements from more practical men engaged in trade, engaged in manufacturing, engaged in export and import, than all the people that have ever been before this committee, a hundred times over. I do not know the object, why they have taken this up, but they have presented the names of people, the names of firms, hundreds and hundreds and hundreds of people throughout the country——

Mr. WOOD. It is not possible that they might have selected the manufacturers who were favorable to it?

Mr. LITTAUER. Yes; that is true, but don't you think the men that might come here might also be selected? I think they have brought before us the greatest amount of popular testimony that has ever been gathered together on the subject. I know it has impressed me.

I must go downstairs and adjourn my committee. I feel that the time has come that you ought to give the House an opportunity of considering this matter—that you must take action now. I do not believe that any number of hearings you could hold could add very much to the information or understanding you can have in reference to this subject, and I appeal to each one of you to let the House vote on this matter, and I trust you will make a favorable report on the bill and make it so we can be heard on this subject.

Mr. LOVERING. I would like very much to have you or some one else say where this country is going to save millions of dollars by the adoption of the system. You said you got along with six less clerks.

Mr. LITTAUER. Yes.

Mr. LOVERING. It seems to me it would necessitate my taking on six clerks if I have dealings with the Government——

Mr. LITTAUER. In the first place, what proportion of the transactions are dealings with the Government?

Mr. LOVERING. I can not say, but with the budget we have it must be a tremendous amount.

Mr. LITTAUER. The transactions to and fro in the country are at least—well, I don't believe that the Government transactions are more than 1 or 2 per cent of the transactions of the country.

The CHAIRMAN. We can easily tell. The total expenditures of the Government each year are from $600,000,000 to $700,000,000.

Mr. LITTAUER. I believe the commerce of the United States is supposed to be a good many billions; I believe I have read $92,000,000,000.

The CHAIRMAN. About $15,000,000,000 of manufactures alone.

Mr. LITTAUER. I will not proceed any further, but I do want to ask you to pass upon this measure if you can and if the majority of the committee can feel warranted in submitting it to the House they surely should submit it so we will have a chance of being heard at this session. If the bill should pass the House it has got to go through the Senate, and there again it would meet with considerable delay, and if you are going to take action at all it seems to me you ought to take it now, for I do not believe all the hearings you would allow would convince you any more than those you have had, and I think the reports of the Congress when Mr. Stone was chairman of this committee are about as convincing as anything that could be brought before you.

STATEMENT OF MR. C. L. DUVIVIER.

Gentlemen, I am not an expert on the metric system and do not pretend to go into the fine points of it, but I have been in business for twenty-five odd years and have had pretty close contact with the custom-house and internal-revenue department, as well as the foreign market. I lived abroad for fourteen years, and I can truthfully say that the metric system is the only sensible system conceived by

man, in my estimation, so far. We have as an example here in our business, three distinct, in fact four distinct standards. The internal revenue department gauge and weigh our goods according to pounds and ounces. The custom-house authorities take them up in gallons and fractions, hundredths of a gallon. Mr. Farrington, the United States gauger in New York, and the appraiser take them up in ounces and fractions of an ounce, and we get invoices in liters and decimals of a liter.

Mr. Armstrong, who spoke to you this afternoon in regard to the work of the customs authorities and in regard to the incessant disputes with the custom-house over practically nothing, hit on a very fine point, and it is perfectly correct. The customs authorities come to us with an invoice and they say, "This case of wine contains 2¼ gallons." We say, "No; it doesn't; it contains 2.40." "Well," they say, "we say so, and that's the end of it." There is no recourse; there is nothing at all we can do. We can write to the Secretary of the Treasury, and we can ask for a refund, and if the authorities have passed on it in that way that is the end of it; they will do nothing.

Mr. LILLEY. You have a right of appeal?

Mr. DUVIVIER. We have a case before the Department now that dates back to 1862, and we have not received a decision yet.

Mr. LILLEY. Then some other laws besides a law as to weights and measures are needed to be changed in this country. If a man can not get a fair hearing before the Treasury Department where a wrong has been done him, then some other changes are needed. Is not that a fact?

Mr. DUVIVIER. No; I think we are unable at the present time, with our present system of weights and measures, to clearly state to the custom-house the facts of a case. For instance, a cask of brandy comes in. There is no means of knowing what is in that cask.

A VOICE. Sample it.

Mr. DUVIVIER. We have asked for the privilege of weighing it; they will not allow us to do that.

Mr. Knight comes along. He is possibly the greatest expert gauger in the United States, and any man in the business will take his word as final.

Mr. LILLEY. What process does he adopt to ascertain how much there is in the cask?

Mr. DUVIVIER. He scales the cask—measures the cask geometrically.

A BYSTANDER. How would you find it by the metric system?

Mr. DUVIVIER. Weighing it.

A BYSTANDER. Could he not weigh it now?

Mr. DUVIVIER. No; for the reason that, while you could take the weight in the metric system and figure it out in liters, you could not do that in the English system in gallons, because you have these incessant fractions coming out time and time again. It is all very fine for people to say they can do it. For instance, how many of you gentlemen here know, as a matter of fact, the average strength of a glass of whisky? [Laughter.] I mean to say what do you know about it; do you know that sherry wine is 21 per cent per volume, and whisky only 44 per cent; do any of you realize that sherry is just half the strength of whisky? And why?

Mr. REYNAL. Some gentleman asked a question which I thought was very pertinent that the Professor failed to answer, and I have

a paper in my hand, I think, that will answer it. The question was whether, if the metric system had been in vogue at the time that pipe fitting was originated, we would have had another size of that thing? Now, I want to point out to you that when that was originated there existed the English standard; it was the only standard there, and yet that inch pipe measures 1.48; the inch and a half pipe measures 1.611; the eighth measures 270 instead of 25.

Mr. GINGRICH. I believe that my friend here has a misconception of what the original question was that was asked by Mr. Lilley. He asked whether in France and Germany to-day they are working by a given standard which is different from their old standards.

Mr. REYNAL. No; I don't think so.

Mr. GINGRICH. I can give you a little light on that question. I have thought throughout these hearings that there has been a whole lot of fogginess about it. I have been dealing with that very question. I find that the Frenchman is not using 25.44 to compare with the original inch that he may or may not have used; he has adopted the metric standards in even units, just as we have adopted certain standards that we found suited our purposes best. I have a list of them here that applied to a certain case. It serves as an example for the entire field. Take again the example of the millimeter, the arbor——

The CHAIRMAN. I don't think we want you to repeat that.

Mr. GINGRICH. I am not going to repeat it (continuing)—applied to the milling machine arbor and the milling machine cutter that goes on that arbor. The German standards to-day are 27, 32, 25, 58, millimeters—not one could be substituted for any one of our standards or the English standards, which are five-eighths, seven-eighths, $1\frac{1}{2}$, $1\frac{3}{8}$, and 2. They are using a system which fixes their standard. We are using a system which fixes our standard. The two can not be reconciled and never can be. That is where the metric people are wrong and hopelessly wrong, simply because there seems to be a lack of knowledge among the academic people advocating the metric system as to the machine shops where the machines are actually made.

Mr. LILLEY. I want to ask permission for Professor Webster to reply to some question that he started to answer when his time expired.

The CHAIRMAN. If you know what it is?

Mr. WEBSTER. I know what it is; it is a question of arithmetic. Could I be put under oath? I am only sorry I can not be put under oath, and all the other gentlemen who have spoken and who are here could not be put under oath. Mr. Chairman, there has been a considerable misapprehension here on the simple matter of arithmetic. I want to make one or two plain statements of fact, and if they are not so, here are the gentlemen from the shops, who will correct me.

We have had a great deal about micrometer screws and plug gauges. The gentleman from Syracuse University, who brought a gauge with him and who has just handed it around, has said something about calculations. Gentlemen, the gentleman from Cincinnati this morning talked a good deal in my ear in not an altogether agreeable way, and quoted from the yellow journals about a scientific—and I want to deprecate that by saying that in taking that position you are not going to help your cause. I want to speak on this so-

called " academic " point. He said that we physicists don't handle things. I handle things every day. I handle tools and metals and remove metal and measure things, and that is my business, and then I have to figure it the same as a draftsman—the same as you. I have to figure costs, too, sometimes. Mr. Kent produced a long array of figures here, some of them with seven or eight decimals. I want to know if he ever in his laboratory has to figure anything out to eight decimal places, and if he does he doesn't know much about arithmetic.

Mr. KENT. " I deny the allegation and defy the alligator."

Mr. WEBSTER. I call for the stenographic record. And Mr. Lovering brought a large number of decimals before the committee, which were wrong. For the millimeter, two, five, four, and then comes a nought, before you come to anything more—that is what the fact is. I suppose you don't know now that the yard to-day is defined not by this old yard that has been handed around, but that it is $\frac{3}{3}\frac{6}{6}\frac{0}{0}\frac{0}{0}$.

I want to say this: Mr. Kent says his workmen work to ten-thousandths of an inch. I handed him the gauge while you were out, and asked him to do a little setting. I won't tell you what took place, but I would like to ask him to do it again. Nevertheless, he admits that the man in making up a half-inch plug can work to a ten-thousandth of an inch. I will admit he can do it on an inch, and I wish to say that the limit of shop practice in this country, or I think in any country, is an error of one part in ten-thousandths, and how many decimals it takes to specify that—four. Four figures is all that any man, draftsman or computer or anybody else, ever uses.

(Thereupon, at 3.45, the committee adjourned.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Washington, D. C., Wednesday April 4, 1906.

The committee met at 10 o'clock a. m., Hon. James H. Southard in the chair.

STATEMENT OF MR. WILLIAMS C. FOX, DIRECTOR OF THE INTERNATIONAL BUREAU OF THE AMERICAN REPUBLICS.

Mr. FOX. Mr. Chairman, while I fully appreciate the compliment of appearing before any committee of this House, I must in the outset say that I do not know that I can add or detract very much from what your committee has heard. If my information is correct, the idea of the Littauer bill is to make it obligatory upon the Government in its dealings to use the metric system.

The position which I hold at the present time is not in a real sense a United States official position. It is true that the United States is part and parcel of the International Union of the American Republics, of which all the republics of this hemisphere are members. The Bureau of which I have the honor to be the head is controlled by all these republics and supported by them pro rata, according to the number of inhabitants which they have.

In regard to the metric system itself, I will say that we publish a monthly bulletin in which we endeavor to give, reciprocally, information in regard to the United States and to the other Republics

who are members of the union. This bulletin is published in four languages—Spanish, English, Portuguese, and French. Our object is, if you please, to collate that information from among the countries to the south of us and give as much as we can in the English language for the benefit of our people here. On the other hand, we obtain information from such official sources as we can in the United States and translate it especially into Spanish, Portuguese, and French, as the case may require, for circulation in the countries south of us, in order that those countries may be thoroughly informed in regard to us from a thoroughly reliable source. For that reason the larger part, about 11,000, of our circulation is in the countries of Latin-America.

With that explanation in regard to the Bureau, I will come to the subject-matter with which you are to deal. Of the 21 Republics, including the United States, the other 20 Republics use the metric system. All of their official statistics are given by the metric system. Under an agreement with all the countries, two copies of each official publication of the various countries are furnished to the Bureau and deposited in our library for use there. We use the information there from these publications for our purposes in getting out the bulletin.

Commencing with the first international conference of 1889, that conference which established the International Union and Bureau, a recommendation was there made, signed by the United States as well as by the other Republics, advocating the use of the metric system, and of course, as we all know, various statutes of the United States have made it legal.

We take this information in the metric system, and we give it exactly as they give it. We reproduce the matter from Spanish into English with the metric system. Information in regard to the United States which we cull primarily, of course, from our Bureau of Statistics, which is very thorough, we naturally give in the standard that is used by that Bureau.

Personally, I believe that if we had one system all over this hemisphere there would be many material advantages. I believe that is about all I can say. I shall be very glad to answer any questions that I can.

Mr. Wood. What would be the advantages of the adoption of the metric system?

Mr. Fox. I should assume that the advantage would be that the merchant or manufacturer in the United States reading the statistics from Brazil would appreciate them more thoroughly, and that the merchant or manufacturer in Brazil reading the statistics from the United States would appreciate them more thoroughly. That is one advantage. I speak of that purely as a publisher at the head of a publication.

Mr. Wood. It would be of advantage as far as our international commerce with the South American republics is concerned?

Mr. Fox. It would seem to me so; yes, sir.

Mr. Bowersock. Can you say to what extent the metric system is used in the 20 republics to which you refer?

Mr. Fox. Well, entirely, as far as those matters are concerned with which our Bureau has an interest, and that is the publication of their statistics, their official publications of all kinds.

Mr. BOWERSOCK. Do they buy and sell by that standard?

Mr. FOX. That is my understanding.

Mr. BOWERSOCK. They buy and sell their products and manufactures, whatever they may be, for export and sale on that standard.

Mr. FOX. That is my understanding, sir.

Mr. BOWERSOCK. Can you say what burden, in your judgment, would be placed upon our manufacturers and workers by the adoption of this bill—not the universal application of the metric system, but by the adoption of this bill?

Mr. FOX. No, sir; I do not feel competent to answer that question.

Mr. WOOD. Does the difference in the standard in the United States and that in use in these South American republics interfere in any material degree with our international commerce with these republics?

Mr. FOX. I think there are others who would be more competent to answer that question than myself.

Right here it might be proper for me to state that at one time we endeavored to reduce the equivalents reciprocally; that is, to reduce the metric system statistics into our standards and vice versa. We found that to be very unsatisfactory. Using our best endeavors, we could not avoid errors. So that we simply give the statistics as they are, and reproduce with every bulletin a table of the metric weights and measures.

Mr. WOOD. I just want to say this: The same difficulties that you found in translating the measures and the weights from one standard to the other our domestic manufacturers and exporters in this country would find, would they not?

Mr. FOX. It would seem to be the case; yes.

Mr. WOOD. The difficulties, therefore, that you had would simply be transferred to the United States, as far as our domestic manufacturers are concerned, in relation to their domestic trade?

Mr. FOX. If we retain our present standards; yes; but not if the metric system is universally used for statistical purposes. However, I have not had any experience in the direct exporting and importing of goods. I have to handle this in an entirely different way. I am afraid I would be treading on ground with which I am not familiar if I should undertake to answer a question like that.

Mr. GAINES. When you translated our statistics into Portuguese and Spanish and French and the foreign languages that are used in the South American Republics you had to employ experts to do it, did you not?

Mr. FOX. We have our translators do that; yes.

Mr. GAINES. So that if you employ the metric system you would have to have metric experts for that, would you not?

Mr. FOX. Not at all.

Mr. GAINES. Can you change from metric measures into our English measures yourself?

Mr. FOX. I can.

Mr. GAINES. Do you do it yourself?

Mr. FOX. I just go over the table and do it; yes, sir. It is purely a mathematical matter.

Mr. GAINES. That is your business. You are in that business, are you not? You are an expert?

Mr. FOX. No, sir; I am not an expert.

Mr. GAINES. You are the head of the Bureau, are you not?

Mr. FOX. We do not reduce those statistics.

Mr. GAINES. Why not? Because you have had so much trouble with it?

Mr. FOX. Yes, sir; and because the official statistics of the other countries of the union have the same right of way in our bulletin as those of the United States.

Mr. GAINES. And if a man wants to send his goods to South America on his calculation into the metric system and he loses by it, it is his own loss?

Mr. FOX. Right.

Mr. GAINES. Every tub has to stand on its own bottom?

Mr. FOX. That is what we have to do.

Mr. GAINES. It has caused you so much trouble that you think the best thing is to let every merchant who sells to the South American people do his own translating?

Mr. FOX. Yes, sir.

Mr. GAINES. I think that is a very safe proposition. Can you name the countries that use the metric system down in South America?

Mr. FOX. Yes. The Argentine Republic, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Honduras, Mexico, Paraguay, and Venezuela. Recent statistics from Peru show that they use it.

Mr. GAINES. Do they use the metric system only?

Mr. FOX. Only for those statistics that we receive, their exports and imports.

Mr. GAINES. But the idea that I got from what you said a little while ago is that those countries use the metric system.

Mr. FOX. They do.

Mr. GAINES. You mean to state that they use that only? Is that the fact?

Mr. FOX. I can not say that; but I believe they do, in all their official transactions; certainly they do in all the publications that we receive.

Mr. GAINES. It is not compulsory, is it?

Mr. FOX. I am not able to state.

Mr. GAINES. You stated that the metric system was used under a number of statutes.

Mr. FOX. The United States statutes provide for it.

Mr. GAINES. It is permissible under the act of 1866, but not compulsory.

Mr. FOX. And several others.

Mr. GAINES. Will you please tell me who it was, representing the United States, who signed a certain agreement that you alluded to a while ago, urging the employment of the metric system?

Mr. FOX. Did I make a statement of that kind?

Mr. GAINES. That is the substance of it. You alluded to some international——

Mr. FOX. Oh, yes; the delegation of the United States to the international conference in 1889–90, which met here in Washington; the special committee on weights and measures signed that agreement.

Mr. GAINES. You do not know who represented us?

Mr. FOX. No, sir; I could tell you by referring to the records.

Mr. GAINES. Does not England severely compete with the United States in selling to the South American countries?

Mr. FOX. Yes, sir; but I want to confine myself to my business. I do not want to get off on that. I do not pretend to be an expert on that.

Mr. GAINES. So South America, so far as you know, uses the metric system, but you do not understand that it is compulsory, and England sells and the United States sells there?

Mr. FOX. Yes.

Mr. GAINES. And you have had so much trouble in translating the metric into the English that you let it go by, and every man who sells to the South American republics makes his own calculations of the metric system?

Mr. FOX. I do not think that it is the trouble so much. It has proved unsatisfactory, and we left it that way.

Mr. GAINES. Is it not a fact that the metric system is susceptible, even with an expert, of a great many mistakes and errors, because there are a great many figures?

Mr. FOX. I am unable to answer that.

Mr. GAINES. A number of men have talked to me about that. Mr. Wood, of New York, for instance, who works in both systems, says he uses the English, because in the other he makes mistakes and it takes days to find them, although he is an expert and has had splendid experience, and is a man of about 50 years of age.

Mr. WOOD. What is the amount of our trade with those twenty South American republics, about?

Mr. FOX. I am afraid I can not answer that offhand.

Mr. GAINES. How much is England's trade?

Mr. FOX. We have made a comparative statement, but I am afraid I can not give you the figures offhand.

Mr. GAINES. As England buys about 66 per cent of our exports, do you not think it would be rather embarrassing to us if England did not adopt the metric system and we did adopt it?

Mr. FOX. I am sure I can not answer that.

Mr. WOOD. The bulk of the trade with the South American republics is done with England, is it?

Mr. FOX. Germany has a very large trade there. Our trade, of course, has materially increased in certain countries in Latin America in recent years.

Mr. WOOD. Our trade is of small proportions, relatively?

Mr. FOX. Yes, sir; I am sorry to say that it is.

Mr. WOOD. You think the adoption of this system would increase our trade with those countries?

Mr. FOX. It would seem to me that it would be another element which would get us closer together.

Mr. GAINES. Is not England pretty close together with South America?

Mr. FOX. England is not holding her ground as against other countries—Germany, for instance.

Mr. WOOD. Do you think it is due to the use of the English system on the part of the English manufacturers?

Mr. FOX. I have never given to that matter a thought.

Mr. WOOD. Do you not think that is a practical consideration for us?

Mr. Fox. I should think it would be, and a good many other things. If we had more steamships and various other things, we could get closer to Latin America and we would do more business with them, and I think that is the object of this next conference.

The CHAIRMAN. Are there any other questions?

Mr. DALE. At the bottom of that table of equivalents you have a list of countries which use the metric system?

Mr. FOX. Yes, sir.

Mr. DALE. Among them I find the United States of America?

Mr. FOX. Yes, sir.

Mr. DALE. How do you explain that?

Mr. FOX. Did I say who use the metric system?

Mr. DALE. Yes.

Mr. FOX. I should have said "adopted." It has been adopted by those States that you have there.

Mr. DALE. I understand that. I would like to ask this, however: The greater number of those books circulate in foreign language in southern countries?

Mr. FOX. Yes, sir.

Mr. DALE. Do you not think that that statement would be rather misleading to Portuguese, French, and the Spanish down in South America, that we have adopted the metric system?

Mr. FOX. I never have thought so. We have adopted it. The statutes are here. I never considered that we were giving any misinformation in so doing.

Mr. WEBSTER. May I ask one question?

The CHAIRMAN. If there is no objection.

Mr. WEBSTER. Mr. Fox, you have read a list of those countries that use the metric system. Can you give us a list of those that do not use it?

Mr. FOX. I do not think there are any that do not use it.

Mr. WEBSTER. I would like to ask Mr. Dale if he knows of any South American country that does not use it?

Mr. DALE. I am not testifying as an expert on South America.

The CHAIRMAN. That is just the point. We will try to hear each gentleman, and he will get his own remarks in his time.

Mr. WOOD. I would suggest that another witness be called, Mr. Chairman.

The CHAIRMAN. If there are no further questions, we will call another witness. We have with us Mr. Monaghan, chief of the division of consular reports of the Bureau of Manufactures, Department of Commerce and Labor, and who will tell us what he has to say now.

STATEMENT OF PROF. JAMES C. MONAGHAN.

Mr. GAINES. Is this to be in opposition to the bill?

The CHAIRMAN. He supports the bill, I believe.

Mr. MONAGHAN. I do not know whether I want to put myself that way or not. I will try to state facts, whether they are for or against.

Mr. GAINES. All right.

Mr. MONAGHAN. I will state the facts as I understand them. That is what I would like to do.

The CHAIRMAN. We will accept your correction.

Mr. MONAGHAN. The statement has been made that if we were at the beginning we might be all in favor of this new bill. It seems to me that we are practically at the beginning of a new era in the very large sense of foreign trade. I am familiar with the fact that we had within our own borders something like twenty-two thousand million dollars' worth of trade, which is equal to the entire trade of the outside world. We produce 22 per cent of the world's wheat, some 30 per cent of its gold, 32 per cent of its coal, 33 per cent of its silver, 34 per cent of its manufactured products, 35 per cent of its iron, 36 per cent of its cattle, 37 or 38 per cent of its steel, 50 per cent of its petroleum, 54 per cent of its copper, 75 per cent of its cotton, and 84 per cent of its corn. Last year we produced more corn than that—nearly 3,000,000,000 bushels.

We have become the greatest producers along many lines, and we have not been doing it entirely scientifically, but we are beginning to do it. Splendid work is being done in the Agricultural Department leading that way, and we will be the greatest food producers in the entire world.

South America is just opening up—Argentina, for instance—in a way that is dazzling, equal to our own development, and in some ways surpassing ours. She is improving her ranches. A bull was bought in England the other day for $20,000 to put among her cattle. Brazil is developing her forests and mines, and we have some idea of that comparatively undeveloped part of the world. China and the East are to be developed, we think, in the same way. We have knowledge that the Chinese Empire has at least 225,000 square miles of coal—much more anthracite than we or any other nation. In one province she has 15,000 square miles. Our entire anthracite area is 450 square miles. It is said by some that there are probably 400,000 square miles of coal in China. That country is going to build railroads, and Russia will be developed. So that we really are, in my opinion, at the beginning of a great era in foreign commerce.

Up to the present, in the development of that marvelous trade within our own confines, we have not been thinking much of the outside world. England had it for a great many years under her control. She was at the head of the world; but, because she was careless, and somewhat unscientific, and paid little attention to the great movement that came fifty or sixty years ago on the Continent, she has been losing it, and to a country that adopted all the scientific methods, and that country is Germany. They, the Germans, have achieved marvelous results, and they have adopted every line of scientific thought that would seem to lead to success; and they have adopted this metric system. By every line of analogy and reasoning they were not to be tempted to do it from any love of France, and they had every other reason for sticking to the other system, and they did, to a certain extent, and in many lines they do to-day, in some forms of textiles. They have also done so in France, where they have adopted the metric system. But the German Empire, realizing what foreign commerce was to mean to her and to everybody else, has gone in for the scientific side of it.

I was consul for twelve years at Mannheim and Chemnitz, in Germany, so that I have had a chance to talk with the textile people and to know what they think. All of them that I have ever met, all over the continent, in fact—because I made it a point to go to

other points besides Germany in matters like this—they all favored, without doubt, the metric system. They have the metric system. That is the standard in the German Empire. In all their textile schools they have the metric system and they teach their students methods of conversion of the one into the other, from the metric into the English and from the English into the metric. But the strong reasons why the Germans had to retain, and the French also, the other so-called English system, although they are all struggling to get away from it—the French in every one of the French cities are eager to get away from the complicated form of the English system if they can—is that most of the original automatic machinery used in textiles all over the world was invented in England; and in our own country, in my boyhood, when I was 22 or 23 years of age, the mills in New England, from one end to the other, were filled with machinery bought in Bradford, Leicester, and other parts of England. It was English machinery. And I am not sure that if you go through the mills of New England to-day you would not find much English machinery. That is just as true, and more true, perhaps, of Germany and France than it is of our country. We have succeeded admirably with our machinery, but the Germans were somewhat slower, although they have accomplished wonders in the last fifty years. They bought their machinery from England, and then took Englishmen over with them, as we did. Most of our great industrial concerns in New England in the textile lines were started with Englishmen, Scotchmen, or North of Ireland Irishmen; and that is just as true of Germany. A number of the men that were brought over for the purpose of establishing the textile industries in Germany were Englishmen who remained until the Germans would learn the methods, and on many occasions they have married and remained there. So that, it seems to me, is one reason why, to a very large extent, the Germans and the French were compelled to retain the English measure.

I shall not try to deceive you. I am perfectly satisfied that for all purposes of trade they would be willing to give you the English measure, or anything else. If they find that the people in South America, or in China, or anywhere else, are desirous of a certain number or grade, or anything like that, the Germans will give it to them.

I have been something of a textile man myself, and I have never been able to understand the arguments advanced as to the difference. The question was asked as to whether it would not be just as easy to count on the metric unit as the other. It seems to me just the same. I have measured yarn, when I was a boy, and it seems to me that it would be no different. In fact, I would have less to count in the smaller unit than the larger. I will leave that to the textile men, however.

I will say, in passing, that the German does not recognize any difficulty. He teaches the metric system side by side with the English, and gives them the English, or, for that matter, any other, if they want it, because they make it a point to get all the knowledge they can.

Mr. WOOD. The English system is taught in the German schools?

Mr. MONAGHAN. Yes, sir.

Mr. GAINES. Why?

Mr. MONAGHAN. For the purpose of giving them the advantage of knowing what the others have.

Mr. GAINES. Working both sides of the street?

Mr. MONAGHAN. Practically.

Mr. GAINES. That is what we are doing now, practically?

Mr. MONAGHAN. Yes, sir; the other phase.

Mr. WOOD. We have made this marvelous progress that you have spoken of with the use of the English system, have we not?

Mr. MONAGHAN. It was not because of that system, but because of the resources of the country.

Mr. HARDWICK. Do you think the Germans have progressed because of the metric system?

Mr. MONAGHAN. No, sir; but that was one feature of their progress. That was one element of it. She would not have adopted that system from love of France.

Mr. WOOD. Do you think the German extension of trade has been due to the use of the metric system?

Mr. MONAGHAN. No, sir; that is one factor in the great equation. Then, they are scientific, and their industrial, art, and commercial schools are the wonder of the world.

Mr. WOOD. As a matter of fact, this machinery that is used in the textile industry is under the English system of measurement?

Mr. MONAGHAN. No, sir; it is in the metric system.

Mr. WOOD. That which is used in this country and in France, I thought you said, was in many cases constructed particularly to the English measurement?

Mr. MONAGHAN. They use in France a good deal of the English measurement, but they are desirous of breaking away from it.

Mr. GAINES. If the metric system is compulsory in France, how is the English measurement used at all? If it is illegal, why is it used there at all?

Mr. MONAGHAN. It is like it is in our own country. You may pass laws, but the enforcement of them is an entirely different matter. They do it for the sake of their trade, which is one of the most interesting things to France and Germany. They will allow things to go on and will not insist upon the law being enforced.

Mr. WOOD. The use of the metric system is not universal, even in Germany, then?

Mr. MONAGHAN. Yes, sir; it is, and the other is simply an adjunct to the universality of that. They use the other simply to help their people to know what we are doing and what England is doing.

Mr. WOOD. If both systems are used one system can not be universal.

Mr. MONAGHAN. In that sense it can. It is universal as far as Germany is concerned.

Mr. WOOD. The German manufacturers still have the difficulties of having two systems of measurement?

Mr. MONAGHAN. Yes, sir.

Mr. LOVERING. Is it not a fact that in Germany, in the organization of textile fabrics, they still use English measurements?

Mr. MONAGHAN. Some of them.

Mr. LOVERING. Is it not a fact that they as a rule do it?

Mr. MONAGHAN. Not as a rule. I have here in my hand—without any thought of this committee—a bunch of stuff that was sent to me

from the German Empire the other day, in which they use the metric system. It is clothing for gentlemen.

Mr. LOVERING. I am not speaking of the way the weaves are put up for the markets of the world; I am speaking of the organization of the fabric itself.

Mr. MONAGHAN. Yes.

Mr. LOVERING. What do they take as the number of the yarn to indicate the size of the yarn?

Mr. MONAGHAN. I would not be certain about that.

Mr. LOVERING. Do you not know that in every case they use the English measurement?

Mr. MONAGHAN. No, sir. If you knew it I would not contradict you, because I do not know to a certainty.

Mr. LOVERING. I understand you to say that you do not know whether they do or not?

Mr. MONAGHAN. No, sir. But I do know that in the textile schools they teach both, and the foundation is the metric system. They also teach the English and every other system that they know.

Mr. LOVERING. Are you familiar with any other nation except Germany in that regard?

Mr. MONAGHAN. Not so much so. I am somewhat familiar with Switzerland, Italy, and France.

Mr. LOVERING. In Switzerland, which is more akin to France than Germany, do they not use the English measurement?

Mr. MONAGHAN. I think they are just the same as in Germany. I have here from Switzerland——

Mr. LOVERING. I am not asking how the goods are put up. I am talking about the organization of the fabric itself.

Mr. MONAGHAN. If you say that that is so, I would not contradict you; but if so, it is based upon the statement I made a moment ago, that they have inherited that and have not broken away from it; but their tendency and desire is to break away from it as soon as they can.

Mr. GAINES. When did Germany adopt the metric system?

Mr. MONAGHAN. Just after the war of 1871.

Mr. GAINES. So that thus far, if Mr. Lovering's statement is true, they have not yet been able to drive the people away from the English system in the particular manner that he alludes to, to wit, the organization of these fabrics?

Mr. MONAGHAN. No, sir. The world moves very slowly. In the year 1893 I was at a meeting of the textile people of the German Empire, a large annual meeting, and on October 14, 1893, I wrote a letter to our Government, after I had met these men, and I told our people that the Germans were finding fault with the way the cotton came out of this country. It was wretchedly baled, and it was subject to fire and water and general damage. I have seen a statement this morning, and I think Mr. Lovering has some people going around here protesting against our baling. I reported the whole thing to the United States Government at the time, and a New York paper took me to task as unpatriotic. It suggested itself to me at the time that the best way would be to photograph this stuff, so I had photographs made in Bremen and in Chemnitz and everywhere they came, and here is a photograph of our packing [exhibiting photographs to members of the committee]. That was in 1893. Here

is a photograph of a bale of cotton from this country, and the cotton of Egypt and the cotton of India baled infinitely superior to ours.

Mr. WOOD. Has that anything to do with the metric system?

Mr. MONAGHAN. Yes, sir; with that question I was asked, and the difficulty of making the people see the benefit of a change. We produce 75 per cent of the cotton of the world, and bale 75 per cent of the cotton of the world, and it has taken all this time to get us to see the necessity for baling it better, simply because a vast amount of money is involved in the baling of cotton, and they hate to give up their baling. I have here in this paper the packing of the United States stuff sent to China, which is uncivilized to look at. Therefore, from 1893 to 1906 is thirteen years, and practically nothing has been done to change those conditions. So that it shows how hard it is to get men to see the advantage of doing a certain thing when they have their interests and their money involved in doing the other thing. That is the point of that, and I think it answers that question in regard to forcing people to change.

Mr. GAINES. That first bale there looks like a bursted cabbage, you might say. The baling or material by which it was wrapped seems to have bursted.

Mr. MONAGHAN. Yes; it has gone to pieces.

Mr. GAINES. That does not interfere with the value of the cotton. All we need in that respect would be, the next time, to put better baling around the cotton?

Mr. MONAGHAN. Yes, sir; and it has taken thirteen years to do it, and we are not doing it now as we should.

Mr. GAINES. The metric system has nothing to do with the better baling of cotton.

Mr. MONAGHAN. No, sir; but I brought that forward to show how slowly people move along those lines. That is the purpose of that exhibition.

Mr. GAINES. Right there, can the German Government buy cloth for its army made by purely metric measurement?

Mr. MONAGHAN. I think so. I would say, from my knowledge of the German Empire, that she could.

Mr. WOOD. These pictures represent a poor method of baling or the use of poor materials and bands?

Mr. MONAGHAN. Yes, sir.

Mr. LOVERING. You introduced them only——

Mr. MONAGHAN. Only to show how slowly these things change. The people have money invested, and they do not like to change. To change would be costly——

Mr. HARDWICK. Why would it be costly?

Mr. MONAGHAN. They have much money invested in tools and machinery, and I can see that it is possible that it would be costly.

The CHAIRMAN. Why?

Mr. MONAGHAN. I say I do not know, but I can imagine that it would be. I have a vivid imagination.

The CHAIRMAN. I wanted to know whether it was just your imagination or whether you had a reason to advance.

Mr. HARDWICK. Do you know of any reason for that opinion?

Mr. MONAGHAN. No, sir; I have no reason. All I have knowledge of is the fact that the Germans and the Italians and the Swiss that

I have talked with have a constant tendency or desire to break away from the English system.

Mr. HARDWICK. I understand, but what I want to get at is this—you have just expressed an opinion that it would involve considerable expense to make this change, because it would make necessary a change of tools.

Mr. MONAGHAN. I did not say that. I said that I supposed that it would.

Mr. HARDWICK. That is what I say—you expressed the opinion. On what do you base that opinion—from your knowledge or conversation with those Germans and Swiss?

Mr. MONAGHAN. I base it on what I have just submitted—that it would be costly for them to change their machinery.

Mr. HARDWICK. On what do you base the opinion that they would have to change the machinery?

Mr. MONAGHAN. I do not know. I have no basis for it. I was simply supposing that they might.

Mr. LOVERING. What machinery?

Mr. MONAGHAN. Tools and general manufacturing machinery.

Mr. HARDWICK. Do you get that from your conversation with people in Germany or anywhere?

Mr. MONAGHAN. No, sir; that is just my general idea.

Mr. GAINES. This bill is confessedly a bill as an entering wedge to make the people of the United States adopt finally the metric system. It is a bill that compels the Government of the United States, beginning in 1908, to adopt the metric system of weights and measures. Now, then, we are using the metric system and the English system both, and have progressed, as you have stated it, splendidly, under both systems, you may say. If we come along here and make the Government adopt the metric system as a compulsory system, it will drive out the English system, and the friends of this measure confess that that is one of the purposes that they have this bill up for. If it succeeds in driving out the English measurements and compels us to use the metric system, then England will increase her trade down in the southern countries, will she not, because she is using still the English measure or the English measure and the metric measure?

Mr. MONAGHAN. No, sir; I do not think anything of the kind, because your trade in South America that will be driven out is a mere bagatelle compared with the trade of Germany and England.

Mr. GAINES. We are selling, say, to an English firm in South America, and we can sell to them in the English measure very easily as against those who are selling in the metric measure. If we adopt the metric system and England does not adopt it, will she not take that customer away from us?

Mr. MONAGHAN. I do not think any such thing will happen. I think where we will have trouble will be with Italy and France and Germany, and they are all using the metric system. They are the ones that are making rapid strides in South American trade—Italy especially. Italy is making the most rapid strides in textiles and manufactures of any country on the face of the earth, because she is now getting water out of her hills, which is the cheapest power in the world. Formerly England had all the coal, and we have got it now, and that is a very important factor.

Mr. WOOD. You think our great competitor is Italy?

Mr. MONAGHAN. In South America she is our chief competitor, I should say, as far as she goes. England is losing and Germany and Italy are gaining in South American trade.

Mr. GAINES. You say Germany and England use all the measures?

Mr. MONAGHAN. No; I did not say that. I said the basis of Germany was the metric.

Mr. GAINES. But she uses both the English system and the metric system?

Mr. MONAGHAN. Yes, sir.

Mr. GAINES. If we stop using the English and go to using the metric system, we will be using one measure?

Mr. MONAGHAN. Yes, sir.

Mr. GAINES. Do you not think it is wise, then, to let everybody who wants to use and sell through the metric system do it, and everyone who wants to use and sell through the English system do so?

Mr. MONAGHAN. I am not sure but what that would be the best thing.

Mr. GAINES. If we adopt this compulsory bill, that drives out the English system. Do you think it is wise for us to do it?

The CHAIRMAN. Drives it out from where?

Mr. GAINES. Prohibits the people from using it.

The CHAIRMAN. Oh, no.

Mr. MONAGHAN. I am not prepared to answer that.

Mr. BOWERSOCK. Have you any idea that any law could be passed by this Congress that would compel our people to use any particular system in its dealings with some other nation?

Mr. MONAGHAN. My experience for the last forty-five or forty-six years would tell me no.

The CHAIRMAN. When you said that in Germany they use both systems, you had reference to the textile industry?

Mr. MONAGHAN. They use the English system in the textile industry, and in most other work they use the metric. That is the great standard in all their work. In everything outside of textiles, unless there is something that they got in the same way, or similarly to the way, in which they got their textile machinery from England. To-day in Chemnitz a large number of mills are fitted with English machinery, after all their experience.

Mr. GAINES. Do you want the Government of the United States and the people of the United States to adopt the metric system and drop the English system entirely?

Mr. MONAGHAN. I do not know. My impression is yes. I am not sure. I think it would be better for us and better for the whole world, because I believe in the metric system myself.

Mr. GAINES. You do not believe in the English system?

Mr. MONAGHAN. No, sir; I do not take any stock in that statement that there would be any difficulty. I am satisfied that the decimal system is the simplest. In hundreds of things, wherever we can, we turn from the other systems to the decimal for the purpose of getting quicker results.

Mr. WOOD. As a theoretical matter you think it is a good system?

Mr. MONAGHAN. I think it is a good system both theoretically and practically.

Mr. LOVERING. Are you a practical man?

Mr. MONAGHAN. I have been all my life.

Mr. LOVERING. You said you were familiar with textiles?

Mr. MONAGHAN. I was when I was a boy.

Mr. LOVERING. Could you transpose into the metric system at once the organization of a fabric which was made of 100 threads one way and 50 the other, and a certain number of yarn, and so many yards weight to the pound? Could you transfer that at once?

Mr. MONAGHAN. I do not think I could; but a boy trained in those German textile schools could, in an instant.

Mr. LOVERING. How long do you think it would take a boy to learn that—not to do it by table?

Mr. MONAGHAN. I do not think it would take a very long time. That is my impression. They have short courses——

Mr. LOVERING. Have you undertaken to do it?

Mr. MONAGHAN. No, sir; I do not remember that I have.

Mr. LOVERING. Why do you think it would take only a short time, then?

Mr. MONAGHAN. Because I think the transfer from any figures in a decimal system should be easy to anyone familiar with the decimal system.

Mr. LOVERING. An inch, I understand, is 25.399 millimeters.

Mr. MONAGHAN. I think that is about right.

Mr. LOVERING. So that a piece of cloth 150 threads, not exceeding 200 threads to the inch, would amount, if transposed, to 108.751 millimeters and 0.3125 of a yard, would it not?

Mr. MONAGHAN. I suppose it would be, if you have it there. I have never figured it up on that basis.

Mr. LOVERING. I have figured it, and that is what I make it; or, to the pound, 453.593 grams. How are you going to transpose that? I would like to have some one who is practical do that in a shorter system than that.

Mr. MONAGHAN. I have never done it.

Mr. LOVERING. But you said that it was perfectly easy for any boy to do it.

Mr. MONAGHAN. I should imagine it was, to transfer from one to the other.

Mr. LOVERING. By a table?

Mr. MONAGHAN. Yes; or by figuring. I am sure they find no trouble in doing it, because they make it a part of their system. There is more or less difficulty with it, of course, or they would not have to teach it. Anything that is taught involves some difficulty, of course.

Mr. WOOD. It would require a great deal of abstruse calculation, would it not?

Mr. MONAGHAN. I do not know that it would.

Mr. LOVERING. Do you know that it would not?

Mr. MONAGHAN. No, sir.

Mr. LOVERING. Do you think that the metric system is a natural system—more natural than the English system?

Mr. MONAGHAN. I do not know what you mean by "natural." I think it is a simpler system, in the sense that we deal with decimals in our work, which are much easier than the figures under the other system.

Mr. LOVERING. Why was it not adopted years ago? In the first instance, I understand that leaving the metric system for the dual system was in the time of Julius Cæsar and Augustus, when we added two months to the year. The year was divided into ten months and we made it twelve.

Mr. MONAGHAN. Yes, sir; I do not know why they did that; and there are lots of other things that they did do that we have changed since.

Mr. LOVERING. We have not changed that.

Mr. MONAGHAN. We are going to, I think.

Mr. LOVERING. How?

Mr. MONAGHAN. This bill is on the way to change part of it.

Mr. GAINES. What is your business, Professor?

Mr. MONAGHAN. Chief of the division of consular reports in the Department of Commerce and Labor.

Mr. LILLEY. Do you think, as a practical man of the experience that you recite you have had, that it is the better plan to compel the people of the United States to adopt this metric system or to let them gradually transfer their business into that system as they see its beauties and its wisdom?

Mr. MONAGHAN. That is a great problem whether it is or not.

Mr. LILLEY. That is the problem that confronts us, and that is what we want to know.

Mr. MONAGHAN. I have to admit that it is a great problem—whether to force people to do that which they ought to do or to let them do it themselves.

Mr. LILLEY. There is no moral question involved in this.

Mr. MONAGHAN. No; I do not say that there is, but it is a question whether a nation ought to do that.

Mr. LILLEY. You are not ready to give an opinion upon that, then?

Mr. MONAGHAN. No, sir; I hesitate to express an opinion upon that. It is too big a question.

Mr. HARDWICK. You said just now that the decimal system was the most natural and logical system—that is, for the purposes of computation?

Mr. MONAGHAN. Yes, sir.

Mr. HARDWICK. For the purposes of the ordinary transactions of life, the ordinary division which first suggests itself to the mind of man is into halves and quarters, and so on, is it not?

Mr. LOVERING. He declined to say that it was more natural.

Mr. MONAGHAN. I only expressed my opinion in regard to it.

Mr. HARDWICK. I understand.

Mr. MONAGHAN. Of course if you go away back to the Indians and the savages, they probably had a much simpler way than we have, but I take things as I find them. If I can get around to the decimal system I do it as fast as I can.

Mr. GAINES. What are the aliquot parts of ten?

Mr. MONAGHAN. Two and five.

Mr. GAINES. What are they of twelve?

Mr. MONAGHAN. Two, three, four, and six.

Mr. GAINES. You can subdivide twelve more than you can ten. Is not that the reason why we have twelve months instead of ten, and twelve inches to a foot, etc.?

Mr. MONAGHAN. No, sir; I do not think so at all. I think in all work in mathematics and statistics when we can get into tens we get there as soon as we can.

Mr. LOVERING. Do you understand that if the Government adopts this bill all these books will cease to be folios and quartos and octavos, and so on, and will have to be figured on the metric system?

Mr. MONAGHAN. I could not say, sir.

Mr. GAINES. All our land, when it is resurveyed, will have to be unhorsed and measured up by the metric measure?

Mr. MONAGHAN. No, sir; I can see that the prejudices of the past are attached so closely to men that it will probably stick.

Mr. GAINES. Last Congress, or the one before, when the bill was reported from this committee, they omitted the public lands from being comprised in the metric system. You did not know that?

Mr. MONAGHAN. No, sir; but if I had my way about it I would put it all on the metric system, whether lands or anything else.

Mr. GAINES. That surprises me very much, for this reason: A few moments ago you said that Germany used all the systems; that England used all the systems, and that that was to satisfy their trade, etc., and that Germany was progressing very rapidly, and so on. Now, we are using the English system and the metric system, and everybody uses it that so desires; there is nothing compulsory about it; yet you would want to change us from the English system entirely and compel us to use the one metric system, when our main competitors we have use both.

Mr. MONAGHAN. You are making me say what I did not say. I did not say England was using them all. I said Germany was, and that she had her purpose in so doing.

Mr. GAINES. I said Germany and England.

Mr. MONAGHAN. As a matter of fact, we buy from Germany almost entirely manufactured products. We sell her almost entirely raw products. She buys over 1,000,000 bales of our cotton and sells from $40,000,000 to $60,000,000 of cotton goods. In one year—1892 I think—in my consulate I sent $11,000,000 of manufactured products to this country, most of which was cotton goods.

Mr. GAINES. Suppose I were to order a certain machine from Germany made on the English measurements, would Germany permit my order to be filled?

Mr. MONAGHAN. I think so.

Mr. GAINES. Then they allow the German people to use both the metric and the English system?

Mr. MONAGHAN. I am not sure about that, whether she would or not.

Mr. LOVERING. Are the watches that they use in Germany divided in time on the face like ours or by decimals?

Mr. MONAGHAN. I think they are divided like ours.

The CHAIRMAN. We have a good many witnesses to appear before us. Are there any further questions?

Mr. WEBSTER. Will you tell me how many years you lived in Germany?

Mr. MONAGHAN. Twelve years.

Mr. WEBSTER. Did you ever buy anything or see anything exposed for sale in any other than the metric system?

Mr. MONAGHAN. No, sir.

Mr. WEBSTER. I want to make this suggestion to counteract what has been a false impression. Mr. Gaines keeps making the witness admit that Germany uses both systems. I think that is a false suggestion——

Mr. GAINES. I am not here to be lectured by you, sir.

Mr. WEBSTER. I beg pardon. I am talking to the witness, and not to you, Mr. Gaines.

Mr. GAINES. You are talking where I am, and where I can hear you, and——

Mr. WEBSTER. I beg pardon.

Mr. GAINES. I took the words from the gentleman's own lips.

The CHAIRMAN. I think that we would have no trouble in establishing that the metric system is used generally.

Mr. WEBSTER. The witness said that he never saw anything for sale in Germany in any other than the metric system. Did you ever see anything for sale in France in any other system?

Mr. MONAGHAN. No, sir.

Mr. LOVERING. Did you ever see cotton sold in any other way than by the pound?

Mr. MONAGHAN. I can not say that I ever saw any cotton sold. They buy it all here.

Mr. LOVERING. No; they have cotton for sale there.

Mr. MONAGHAN. They have their Bremen exchange, lately.

Mr. LOVERING. I have an agency myself, in Bremen.

Mr. MONAGHAN. They have their Bremen exchange, and they stick to the English, because we dominate in the cotton trade.

Mr. LOVERING. They buy it in all cases by the pound?

Mr. MONAGHAN. I should imagine so. I never saw cotton sold, but I can understand that that is true, because the cotton comes mostly from us.

Mr. WEBSTER. Did you ever see in Switzerland weights or measures in anything but the metric system?

Mr. MONAGHAN. No, sir.

Mr. WEBSTER. Did you ever hear of any?

Mr. MONAGHAN. No, sir.

Mr. WEBSTER. Do you think there are any?

Mr. MONAGHAN. No, sir.

Mr. WEBSTER. Or in France?

Mr. MONAGHAN. No, sir.

Mr. DALE. Mr. Monaghan, were you stationed near Saxony?

Mr. MONAGHAN. Yes; in Saxony.

Mr. DALE. That is a large knitting center?

Mr. MONAGHAN. Yes.

Mr. DALE. What are the gauges of the knitting machines based on?

Mr. MONAGHAN. They are based on both the English and the metric system, for this reason: The most of their knitting machinery was bought in England and only in recent years they brought their machinery over there, and before going over to the other, they had to use the English, and to bring English workmen over.

Mr. DALE. Do you not know that the Leipzig inch is the leading standard of knitting gauges in Saxony?

Mr. MONAGHAN. I do not know that.

Mr. DALE. I am informed so by a large number of authorities. You say you have never seen anything sold except by the metric system. Have you noticed how cotton yarn is put up in Germany?

Mr. MONAGHAN. No, sir. You mean, put up for sale by the Germans?

Mr. DALE. Yes.

Mr. MONAGHAN. No, sir.

Mr. DALE. If you did not, let me say that all the leading authorities agree, and all the technical books and the textile calculations are based on the bundle of 10 English pounds; and that all the yarn numbers in Germany are based upon the English system of hanks per English pound.

Mr. MONAGHAN. May I answer that right there? That is due to this fact, as I have been trying to impress, that England had a dominance in the continental market, which she has lost to-day, as to manufactured products. She is selling yarns and she dominates the yarn market. They are selling yarn to Germany, but the whole tendency, both in cloth and yarn, is to get away from the English system to the metric system as soon as possible.

Mr. DALE. You have had quite a good deal of contact with the textile trade in Germany?

Mr. MONAGHAN. Yes, sir.

Mr. DALE. You said you found no one who was not in favor of the metric system?

Mr. MONAGHAN. Not that I remember of.

Mr. DALE. There is a German tariff which just went into effect——

The CHAIRMAN. I think we shall have to curtail this.

Mr. DALE. You can take it out of my time here, Mr. Chairman. We have four hours to a side, and I am on the opposite side.

The CHAIRMAN. If you are called upon. We have other witnesses, do not want the time taken up by one witness.

Mr. GAINES. Yes; let us have another witness.

Mr. LILLEY. Let us hear somebody on the other side.

Mr. LOVERING. I would like to hear some practical man on that side. This gentleman knows nothing about what he is talking when he comes down to the use of the metric system in this case, in the manufacture of textiles. It is useless to waste any time with him. If they have some one on that side who does know about it, it would be instructive to the committee to hear him.

The CHAIRMAN. Somebody who has had actual experience over there?

Mr. LOVERING. Yes; and who knows. This gentleman has to answer all the time, "I do not know."

The CHAIRMAN. I do not think we have anybody here who has had actual experience in the manufacture of textiles on the other side.

Mr. GAINES. Let us call for somebody.

Mr. TOWNE. Do you know what the Rhenish foot is?

Mr. MONAGHAN. No.

Mr. TOWNE. You have been in the Rhein province—Cologne?

Mr. MONAGHAN. Yes, sir.

Mr. TOWNE. You do not know that in every hardware shop, if you ask for a carpenter's rule, which they make meter lengths, that they

will show you a rule on one side graded in the meter and on the other in the Rhenish foot, and that the carpenters and masons all through the Rhenish provinces use the Rhenish foot for their work, and not the meter?

Mr. MONAGHAN. No, sir.

The CHAIRMAN. We have some gentlemen here who, I suppose, are on the other side, for the reason that they have previously appeared in opposition to this legislation, and who wish to be heard.

Mr. GAINES. Mr. Lovering wants to continue the examination on the pro side. I am perfectly willing, if they get a man favoring the metric system and can explain it in cotton business.

The CHAIRMAN. If you know of anybody.

Mr. GAINES. Is there anybody here to testify on the cotton proposition?

Mr. WEBSTER. Would you tell me how exact you want an answer to your question?

Mr. LOVERING. I want this much of an answer: To tell me how you would transpose into the metric system the organization of a piece of cotton.

Mr. WEBSTER. There seems to be no textile man here, but I can tell you how I would do it if you will tell me what you want done. How precise must the answer be?

The CHAIRMAN. His measurement represented one ten-thousandth of an inch.

Mr. WEBSTER. Does that represent the state of the textile art?

The CHAIRMAN. No.

Mr. WEBSTER. I would like to answer his question, if he would ask it.

Mr. LOVERING. If you are going to be as exact as you are in the English system, you have got to get down to that; when you say 840 yards to a pound of yarn, and so many skeins in a pound, you know what the number of your yarn is.

Mr. WEBSTER. Yes.

Mr. LOVERING. And exactly what it is.

Mr. WEBSTER. I beg pardon. Can you weigh to better than one-tenth of a per cent?

Mr. LOVERING. That is not the question.

Mr. WEBSTER. I think it is.

Mr. LOVERING. It is not the question of what you can weigh to.

Mr. WEBSTER. Are you in the textile business?

Mr. LOVERING. Yes.

Mr. WEBSTER. How accurately can you determine your 840 yards?

Mr. LOVERING. I think you escape my question. What I am after——

Mr. WEBSTER. I will tell you how to do it. If you have so many pounds per yard, take your pounds and reduce them to kilograms, and take your yards and reduce them to meters, and divide one by the other, with any degree of exactness that you demand. And when you say that the inch represents 25.399 millimeters and so on, I deny it.

Mr. LOVERING. I will give my reason for saying that. This bill seems to be a very ingenious device to bring in the alteration of the

tariff, Mr. Chairman. If you pass this bill, you will have to pass a bill revising the tariff immediately. What does the bill say?

The CHAIRMAN. I think we will hear the witness first.

Mr. LOVERING. This is in the line of answering his question.

The CHAIRMAN. You are going off on the tariff now.

Mr. LOVERING. Let me finish my sentence and I will stop.

The CHAIRMAN. Very well.

Mr. LOVERING. When that piece of goods comes to the custom-house, under this bill it can not be counted so many threads to the inch or in the warp, and so many threads in the filling added together, and then so many square yards of that to the pound. You would have to transpose that immediately into the metric system, would you not?

The CHAIRMAN. Possibly.

Mr. LOVERING. You have got to do it. The law says so, or this bill says so.

Mr. WEBSTER. The German manufacturer will bill it to you in those units.

Mr. LOVERING. What will our expert here do?

Mr. WEBSTER. I can not tell. I can not tell how good a man he is.

Mr. LOVERING. The law is very explicit. He is obliged to do it. The law says:

Cotton cloth not bleached, dyed, colored, stained, painted, or printed, exceeding 300 threads to the square inch, counting the warp and filling, and not exceeding 2 square yards to the pound, 4 cents per square yard.

Tell me how you are going to do that in the metric measure and yet come up to the Government requirements?

Mr. WEBSTER. Yes, sir. I will reduce all those things. In the first place, I will ask the official who interprets that law—for it has to be interpreted; it is not like the Bible, that comes down from God—the law——

Mr. LOVERING. Which law?

Mr. WEBSTER. The tariff law. [Laughter.] This thing has to be applied by somebody, as I understand, a customs inspector, on the dock or in the warehouse. I will tell him that there must be in every system of measuring a certain limit of tolerance.

Mr. LOVERING. But you are taking another system entirely.

Mr. WEBSTER. I want to find out what your system of tolerance is. If you say one in a thousand is near enough, I will do it that way. If you say one in ten thousand is near enough, I will do it in that way.

The CHAIRMAN. Under our table of equivalents as enacted into law, where you have so many threads to the inch, would there be any trouble in determining how many threads there would be?

Mr. LOVERING. It can be done. I understand that.

The CHAIRMAN. Would it not be very easy and a perfectly natural and legal thing, to take the table and make your computation, because you have a perfect guide in the statute?

Mr. LOVERING. I do not think the Department would have any liberty, under this bill, to use this present system of organization.

The CHAIRMAN. I can see no difficulty about it.

Mr. WOOD. Why?

Mr. LOVERING. Because it says all the departments of the Government of the United States, in the transaction of business requiring the

use of weights and measurements, shall employ and use the weights and measures of the metric system.

Mr. WEBSTER. I will tell you how to do it.

Mr. LOVERING. I have asked a question.

Mr. WEBSTER. If you have it by the inch, multiply by 10 and divide by 25.

Mr. LOVERING. By 25 and a fraction?

Mr. WEBSTER. Twenty-five and four-tenths. If you want it nearer than 2 per cent, it would take a little longer. That is near enough for all the woolens. I never saw yarn that I could not measure the diameter of to 2 per cent.

Mr. LOVERING. But the Government says it is so much per pound.

Mr. WEBSTER. I know; but this law will modify that.

Mr. LOVERING. It is not by kilo or kilogram; it is "exceeding 300 threads to the square inch, counting the warp and filling, and not exceeding 2 square yards to the pound, 4 cents per square yard." You have to reckon the whole of that thing down to the metric system. My only object in bringing that phase of the matter up is that the Government is obliged to collect its duties in that way.

Mr. WEBSTER. What do you do with the ad valorem duty? Do you not have to translate from pounds and so on to dollars?

Mr. LOVERING. Those are values.

Mr. WEBSTER. These are values. I can not see any difference between reckoning money and reckoning weight, and it is my business; I am reckoning every day.

Mr. GAINES. What is your business?

Mr. WEBSTER. Professor of physics; physicist.

STATEMENT OF PROF. SIMON NEWCOMB.

The CHAIRMAN. Please state your profession, Professor.

Professor NEWCOMB. I am an astronomer by profession, and chairman of the committee of the American Meteorological Society, which is urging this bill now before the committee.

I rise to make a very brief and comprehensive review of the state of the case and of the advantages which it seems to me will arise from this bill, and especially to consider the disadvantages which have been alleged to be connected with it.

The purpose of the bill, Mr. Chairman, is simply this: I suppose that every scientific man or every physicist in the world who has to do with investigations is struck by the superior simplicity with which computations are made and the relations of quantities made clear by the metric system over the ordinary one. Commercial men must also be struck by the great advantages that would arise from the use of one and the same system all over the world. That simplicity is introduced through the metric system, especially in computations and additions, is something that can not be disputed at all, on solid grounds; but it is impossible for me to go into the whole state of the case. I once heard of an English accountant who, being accustomed to use pounds, shillings, and pence, and it being suggested to him to use the decimal system, stated that he would be afraid lest he should make mistakes, if he were to divide by 10 instead of 20. [Laughter.] These cases occur the world over. We can hardly allow that everybody should aim at the standard of that accountant.

Secondly, this bill does not in any manner affect the work done in any workshop in this country, a single screw thread, or anything else in any way whatever. It does not affect the way we are doing business all over the country. It merely affects the operations of the Government itself, and the units in which it shall designate its measures. That is all.

A great deal is said about screw threads being in the metric system. The pitch of every screw thread may be expressed both in the English measurement and in the metric measurement. When you express it in metric measure it is in the metric measure; and when you express it in the English measure it is in the English measure. So there is no change whatever produced. There is nothing in that bill that prevents every manufacturer in his contracts with other manufacturers and in his workshops making his own arrangements. There is nothing to prevent every draftsman doing just as he has been doing before up to the point when he sees, as we think he will see, the advantage that will come from metric measures. Then we hope it will come in, little by little, by itself. That is an opening statement of the case.

I have listened with very great interest to the exposition of the gentleman who last spoke, and it seems to me that he is under so entire a misapprehension as to the purpose and effect of this bill that when he sees that it has not any of the evils associated with it that he has been setting forth, he will come around to our side and favor it. [Laughter.]

I will go through some things that he said. He spoke, first, of the fact that in the German workshops, in obtaining specifications for screw threads, they gave the size six threads to the English inch. That only shows how very easy it will be while using the metric system to use English inches if you want to. There is no law in Germany to prevent a manufacturer from making a contract in English if he wants to. There is no other lesson than that that I can draw from the statement.

Secondly, he says that the old German measures still prevail; that the old confusion which led to the introduction of the metric system still exists, and that in different provinces of Germany, Bavaria and so on, they still preserve their old inches, of which they had a separate one for almost every principality which now forms the German Empire. It was to get rid of that confusion that the German Government introduced the metric system as the standard one, and what the gentleman says only shows that it is rather slow in making its way, and that they are rather slow in appreciating the advantage of uniformity over variety and confusion. I can draw no other lesson than that.

The gentleman also spoke of the binary system. There is nothing binary in the English system whatever, not a single binary unit. I could only interpret the application of his argument as saying that we should abolish our present system of feet and inches and introduce a new system in which the foot or other unit should be divided into halves, quarters, eighths, sixteenths, and so on. This bill does not prevent that being done in the workshops, if you choose. You can do it just as quickly in the metric as in any other measure.

Then some other points were made, connected with the use of the old or English system by the Westinghouse Manufacturing Company.

Here I think there must be some slight misinterpretation liable to be put upon his words, when he says that no measure of length is used there at all except the English. It is a fact—and this is one great reason why the metric system is making its way, and why it is being urged—the great fact is that to-day all the units and all the quantities which express the numberless quantities which express the units of the various forces and the various things in nature, weight, electrical resistance, density, force of gravity at various points, everything that comes in, is based on the metric system.

The pressure of steam, for example—everything in the fundamental formulæ that every well-informed manufacturer has to use—I say these are all arranged on the metric system. By carrying this system through to the end you would have more simplicity throughout. That will be done ultimately, when the system is once introduced and as people see its advantages. It would be begun immediately if the true state of the case were seen by the whole country. Such being the case, when you take these fundamental units of pressure, of electrical resistance, and electromotive force and of everything else that comes into play, and all those things based on the metric system, when you pass into the other system you have got to have a welding point, a whole lot of rules and formulæ by which to pass from one to the other. That is unavoidable so long as we continue the English system. Take a length of wire having a certain electrical resistance. That resistance is expressed in terms of length on the metric system, and it is absolutely impossible to design a coil to have a given resistance on the English system without you change from one system to the other. No doubt they have some rules or formulæ for doing that.

The gentleman, again, gave a very simple rule by which the density of iron was determined. That rule is undoubtedly good for iron on the English system. It would be just as convenient and just as good on the metric system. But what he says applies only to iron, and only to a particular grade of iron or steel. No matter what it is, in order to apply the rule to any different grade you have to increase or diminish the percentage. But the metric system applies to everything that you have to measure and weigh.

So much for what the gentleman has said. I think I have covered all the points that he has brought up here and showed that there is nothing at all in what he has brought forward that presents any difficulty or objection which does not apply to one system just as much as it does to the other, and that he has not pointed out one single disadvantage except on the point of Government contracts. Here a few very simple calculations are necessary to change one system into the other. The labor of making those computations by the Government or the individual that will be involved will be infinitesimal as compared with the advantages of the system.

Now, Mr. Chairman, I don't see the point of the objections to this bill. This Metrological Society, which has been in existence for forty years—thirty-five or forty years—has nothing to gain individually for its members by this; we simply want the public at large to see the advantages of using the metric system and gradually to come to use it simply for their own benefit, in the matter of saving labor. The advantages were set forth at length in previous hearings and

those advantages are to be found set forth in documents that are accessible, and it is not worth while for me to take up the time of the committee in going over them.

Mr. LILLEY. I want to know what practical experience you have had in the manufacturing lines?

Professor NEWCOMB. None whatever.

Mr. LILLEY. Is it not a fact that the Government of the United States, through its naval and military academies, is turning out some bright engineers?

Professor NEWCOMB. Undoubtedly.

Mr. LILLEY. They rank with the men engaged in outside business in the same profession?

Professor NEWCOMB. Undoubtedly.

Mr. LILLEY. For forty years they have been in control of some of these Government institutions where it is proposed to make the metric system compulsory—for forty years they have had the right to use the metric system?

Professor NEWCOMB. Yes.

Mr. LILLEY. Now, the fact that those well-educated men who are dealing with the practical things of this life have not seen fit to adopt the metric system is something we ought to take into consideration, and does that shake your judgment in any way in connection with this matter?

Professor NEWCOMB. Not at all.

Mr. LILLEY. You put your theoretical opinion against the practical experience of the best-educated men the Government can produce and has produced for forty years?

Professor NEWCOMB. I do not; because those best-educated men have never given the question sufficient attention, I take it. I do not mean to say that they have not given the whole subject any attention, but I mean to say they have never seen as between the question on the one side of adapting their instruction to the best interest of the State and the country and on the other side of simply making it scientific, they have drawn the line at a certain point. It is impossible to understand the steam engine without understanding the metric system, because the elements of quantity and measurement which express the density of the steam and its pressure are given in metric units, in the metric system, but that system can at certain stages be changed into the common system, and I have no doubt that may be done at the beginning of the course, and then you may go on and make the instruction on the English system.

Mr. LILLEY. You are not an attorney, I suppose?

Professor NEWCOMB. Not at all.

Mr. LILLEY. You would not undertake to explain the law?

Professor NEWCOMB. Not as a general thing.

Mr. LILLEY. We have had here upon the statute for forty years an act giving them the right to do this.

Professor NEWCOMB. Giving whom the right?

Mr. LILLEY. Anybody. They have not seen fit to adopt it, and now we produce a bill—a bill is brought before us which says that they shall——

Professor NEWCOMB. Who shall?

Mr. LILLEY. The Government officers shall employ and use the weights and measures of the metric system. Now, do you mean to say that the officers of the Government, following out this bill, will not obey it?

Professor NEWCOMB. I hope they will obey it.

Mr. LILLEY. You want them to do that because you want, so far as in you lies, the power to in some way or other transform our system and adopt the metric system?

Professor NEWCOMB. Ultimately, I want to secure the transformation and adoption of the metric system when it is perceived that it is to the advantage of the country generally so to do.

Mr. LILLEY. Do you not think the practical experience of the best-educated men in the United States is better to rely upon than your theoretical ideas?

Professor NEWCOMB. When you will tell me how many of the best-educated men are opposed to the metric system I can answer that better.

Mr. LILLEY. Take the last witness before us. He has been having practical experience where these principles are actually applied. I am referring to Mr. Mattice. He is apparently a bright man. He has had as much experience as almost anyone. Take Mr. Towne, for instance. He at one time, as he tells us, was favorably inclined toward the metric system, but he now condemns it. Now, do you think his judgment is worth anything?

Professor NEWCOMB. Why does he condemn it?

Mr. LILLEY. He gives us his reasons.

Professor NEWCOMB. Yes; but the only reasons I heard for preferring the English system were evidently based on misapprehension. The same misapprehension existed in the mind of the gentleman who preferred the pound divided into 20 rather than 10 because he was afraid he would make mistakes.

Mr. GAINES. Your name is Prof. Simon Newcomb?

Professor NEWCOMB. Yes, sir.

Mr. GAINES. I see that you sent me or caused to be sent to me a publication from the American Metrological Society, dated March 6, which starts out "Dear Sir," and it is signed by you as chairman of the society and Mr. Coe as the secretary, and in which you use this language:

> Under present conditions the British system is an ugly excrescence in the world's literature and practical arts which the world's welfare demands we should abolish as speedily as possible.

Now, do you think the present English system is an excrescence in the world's literature and practical arts?

Professor NEWCOMB. Sometimes in the haste of drawing up papers we do not express them in as conservative language as we would wish to express if called to make a statement upon the witness stand.

The CHAIRMAN. You do not think that is profitable, do you, Mr. Gaines?

Mr. GAINES. Certainly; I wanted his reasons for making that statement.

STATEMENT OF MR. J. W. HARRINGTON, OF THE NEW YORK HERALD.

Mr. HARRINGTON. This is a summary of the investigation of the present so-called English system of weights and measures, conducted by the New York Herald. It extends over a period of four months and represents inquiries and examinations made in every part of the United States and other countries. Industrial establishments, factories, large business houses, and institutions of all kinds which are concerned in the trade and commerce were visited. Not only were the views obtained from leading merchants, manufacturers, and persons who handle products in a wholesale way, but hundreds of retailers, such as grocerymen and dealers in all kinds of supplies in common use, gave their opinions. It is found in practically every branch of industry in the United States which clings to the motley crowd of survivals inherited from England that the greatest confusion exists. By actual test scores of educated men met in the course of a single day did not know the ordinary measures of length, volume, and capacity. Many industries were found to be going their own way with systems of weights and measures which even well-informed experts did not thoroughly understand.

In the retail grocery business a pint is anything from 8 ounces to 30 ounces. It is no uncommon thing for berries to be bought by the dry quart and advertised and sold by the wet quart, which is considerably less, but the public accepts both quarts as the same. Such supplies as sugar are sold in New York City and in many other places in the United States by the quarter stone to persons who never heard that a stone was 14 pounds. A quart of apples in the city of New York consists often of as many as the groceryman may grasp in his hand, and he is careful not to get hold of more than four specimens if he can help it. In Nebraska the customer looks wistful and forsaken if he gets less than a peck when he pays for a quart. The New York City board of health expects 231 cubic inches of milk to the gallon; in Minnesota the farmer who furnishes less than 280 cubic inches is put in jail. It was found that the competition among makers of textiles had year by year caused fabrics to become more and more unfaithful to the measurements which are plainly marked upon them. The so-called 10-quarter blanket is supposed to be 2½ yards in length. It is perfectly well known to the trade that it actually measures 2 yards or less. In a hardware store there are eight to ten different gauges. Logs are bought and sold in accordance with sixteen widely varying systems of measurement. It is impossible to buy even a strand of wire or a nail without encountering perplexing and confusing systems of measurement.

Investigation shows that nearly every State of the Union has legislated on the subject of the bushel and has fixed widely differing standards, which provide that a bushel of certain commodities must weigh so many pounds. This especially applies to food supplies, such as fruits and vegetables of all kinds. So confusing are these standards that all the large hotels and restaurants in the city of New York find it impossible to work out a cost system until they have weighed everything which comes into the steward's department. In the conducting of a large hotel supplies are required in 50 to 60 bushels of varying sizes and in from 10 to 12 barrels of different capacities. The

people of the United States are buying and selling in accordance with some seventy standards, many of which the ordinary citizen does not comprehend.

Even in the measurement of land it is difficult under the present system to be exact, and in the large cities the greatest confusion exists. In New York there are Dutch feet, English feet, and American feet to be reckoned in the buying and selling of lots, the value of which is reckoned in millions. In parts of Philadelphia 100 feet are 100 feet and 5 inches when applied to land measurement, and a false measuring tape is manufactured for use in that city where the superfluous 5 inches are gradually lost, and the tape is so marked as though it actually represents the true measurement.

These are only a few instances which reveal the necessity of metrological reform. In practically every trade and calling and every manufacturing industry which clings to the antiquated system of weights and measures inherited from England and modified just enough to throw it out of gear with the English system there is confusion and chaos. Talks with manufacturers and merchants all point to the same thing, and that is that it is time to disperse this tatterdemalion legion and to reorganize the whole army of weights and measures in accordance with the international standard.

The situation is further complicated by the fact that the metric system is used practically by every civilized nation on the globe, with the exception of Great Britain and the United States. Goods coming to this port are invoiced in accordance with the metric units, and they must be converted into the so-called " English system " of weight and measurement before they are sold. Merchants who were interviewed by the Herald tell the same story of unnecessary and brain-racking toil involved in these conversions and of the large expense to which they are put in paying the salaries of clerks and accountants, whose sole business it is to change metric order and common sense into a wretched hodge podge. To meet these conditions innumerable tables and mathematical short cuts have been invented, which apply to only a few instances.

Not only is the importing trade hampered by the lack of an international system, but merchants and manufacturers engaged in the exporting trade have placed themselves on record to the effect that they are at a serious disadvantage in their dealings with the metric countries of the world. This same fact is borne out by interviews with the various foreign consuls in this country. Investigations conducted by the Herald in European centers, like Paris and Berlin, show that American commerce is constantly hampered by the fact that American goods are not usually sold in metric quantities. Men who have had a wide experience in traveling as commercial travelers abroad have testified that the trade of the United States is everywhere handicapped by the failure to adopt the world language of commerce.

It is the awakening to the existence of such conditions as have been described that accounts for the tremendous growth of the metric system within the last fifteen years. Exporters who formerly would not sell in accordance with the international system are now quoting merchandise in metric quantities. Catalogues gathered at random in the wholesale districts contain quotations in both the metric and the so-called " English " systems of weights and measures. New in-

dustries have sprung up which are entirely on a metric basis, as, for instance, the repairing of automobiles. In some of the factories where American automobiles are made only metric measurements are used, and in nearly all cases certain dimensions are invariably expressed in accordance with the metric system. The workmen who are engaged in automobile manufacture are Americans, and they have found not the slightest difficulty in the use of the metric measures. The oculists and opticians of the country employ metric measurements exclusively. Tailors, designers of clothing, the makers of fur garments, are using the metric system. Three thousand expert watchmakers in the factory of the American Waltham Watch Company, Waltham, Mass., employ the metric system exclusively. The development of electricity has also popularized the metric system throughout the country. In accordance with metric terms all contracts for electric lighting and wiring are let and all charges are made.

In the College of Pharmacy, in the city of New York, the students are instructed only in accordance with the metric equivalents, and they learn of grains and scruples only as curiosities of metrology. The United States Pharmacopœia, accepted as the official standard of the United States in the preparation of medicine, gives its directions exclusively in metric quantities. Prof. Joseph P. Remington, the chief editor of that publication, in an authorized statement, set forth the reasons for this important step. The use of the metric system was also advocated by industrial chemists in all parts of the country.

Investigation made by the Herald revealed that representative merchants all over the country are willing, if the slightest encouragement is given in the way of legislation, to adopt the metric system. Such men as John Claflin are among the ardent champions of the metric system. Proprietors of the great department stores in New York City, such as those of R. H. Macy & Co., and Siegel-Cooper Company, appreciating that the day of the metric system is at hand, have made extensive exhibits of the international weights and measures, and have devoted their show windows for weeks at a time to demonstrations of the new standards.

Inquiries made by the Herald in engineering circles show a steady increase in the use of the metric system. Charles H. Haswell, the author of "Haswell's Handbook," a work of reference used by mechanics and engineers throughout the country, and John C. Trautwine, of Philadelphia, another well-known authority, are among the most earnest advocates of the metric system. Sir Henry Roscoe, who occupies a similar position as an authority in England, has also placed himself on record as a supporter of the metric system. Representative men in every State of the Union, whose views were ascertained, give an unqaulified indorsement. In Colorado State officials have joined the prometric forces. The governors of ten States over their own signatures have placed themselves on record as favoring the introduction of the metric system.

Analysis made of the numerous petitions in favor of the metric system, which have been presented to the House of Representatives, shows that the great majority of the signers are practical business men. A card index containing 1,674 names of petitioners in the business section of Manhattan shows that of these 61 are machine and tool makers, 398 are general manufacturers, and 695 are merchants.

Although the position of scientists and educators has been perfectly well known for many years, it is well to call attention to the fact that numerous scientific societies, educational associations, and the like have within the last few months placed themselves on record as favoring the metric system. A canvass of the school board of the board of education of the city of New York showed a majority in favor of the adoption of the metric standard. Dr. Magnus Gross, the president of the New York City Teachers' Association, is one of the leaders of the prometric campaign, and his views are indorsed by hundreds of school principals. A canvass of principals made by the Herald reveals that only 5 out of 200 were unfavorable to the adoption of the metric system.

That the metric system may be easily and quickly learned even by young children was shown by a contest organized by the Herald, in which five test questions dealing with measures of length, volume, and capacity were represented. These problems were prepared from similar ones in which the dimensions were stated in the so-called English weights and measures. First they were solved with the use of algebra, logarithms, and a table of specific gravities, and then they were converted into the metric equivalents. They were solved by hundreds of school children with the use of simple arithmetical processes, and by those many of whom had before the announcement of the conditions of the contest no acquaintance with the metric system. As the metric system is not given in the New York schools except in the last year of the grammar course, many of these pupils acquired their only knowledge of it from charts displayed in shop windows. Yet with brief study they solved these problems correctly, and also wrote essays upon the subject, which showed not only originality, but a thorough grasp of principles.

The statement is made by Dr. David Eugene Smith, of the New York Teachers' College, who is considered the leading authority on elementary mathematics in the United States, that he can teach the principles of the metric system to any child in fifteen or twenty minutes. The results of the metric system contest conducted by the Herald certainly bears out his opinion. They at least indicate that the difficulties in the way of mastering the system are not so great as some of its opponents would have the public believe.

The investigation of the present condition of American metrology would show, therefore, that there is every reason for reform; that all trades and industries would be benefited by the adoption of a standard which is uniform, accurate, and easily understood, adapted to every practical use, and known and accepted throughout the civilized world.

Mr. GAINES. Have you asked any farmers as to whether they would like the metric system?

Mr. HARRINGTON. No; I think it would be an advantage to them, though.

Mr. GAINES. Why don't you ask them?

Mr. HARRINGTON. I have made a number of inquiries from dealers in seeds, who pointed out how it would be of advantage to the farmers.

THE NEW YORK HERALD,
New York, April 9, 1906.

Mr. J. H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures,
Washington, D. C.

DEAR SIR: Referring to my statement concerning the metric system, made last Thursday before the committee, I should like you to submit the inclosed exhibits, which bear out the assertions that I have made.

Exhibit A.—Catalogue of the Brown & Sharpe Manufacturing Company, Providence, R. I. "In a hardware store there are eight or ten different gauges." (See pp. 437 to 462.)

Exhibit B.—Catalogue of the Lufkin Rule Company, Saginaw, Mich. "Logs are bought and sold in accordance with 16 widely bearing systems of measurement." (See p. 60.)

Exhibit C.—Circular of the Department of Commerce and Labor, Bureau of Standards, Washington, D. C., entitled "Legal weights per bushel of various commodities." "Investigation shows that nearly every State of the Union has legislated differently on the subject of the bushel, and has fixed arbitrary standards."

Exhibit D.—Prospectus of Grace's Commercial and Handy Bureau, Grace's Handy Book, No. 120 Front street, New York City. "To meet these conditions innumerable tables and mathematical short cuts have been invented."

Exhibit E.—Catalogues of the Hess-Bright Manufacturing Company, Philadelphia, Pa., and of the Standard Roller Bearing Company, and letter from James H. Birch, Burlington, N. J. "Exporters who formerly would not sell in accordance with the international system are now quoting merchandise in metric quantities."

Exhibit F.—Metric warp tickets of the Duplan Silk Company, Hazleton, Pa., manufacturers of textiles. "New industries having sprung up which are entirely on a metric basis."

Exhibit G.—Catalogue of the American Waltham Watch Company, Waltham, Mass., entitled "Main Springs." "Three thousand expert watchmakers in the factory of the American Waltham Watch Company, Waltham, Mass., use the metric system exclusively."

Exhibit H.—Page from the periodical entitled "Machinery," February, 1906. "Finding the size of blank for a cup." Inquiries in engineering circles show a steady increase in the use of the metric system.

Exhibit I.—List of governors of States who favor metric system. "The governors of ten States over their own signatures have placed themselves on record as favoring the introduction of the metric system." I find, on looking up the matter, that the actual number is twelve governors.

Exhibit K.—Sample set of questions sent to the school principals of the city of New York. "A canvass of principals made by the Herald revealed that only 5 out of 200 were unfavorable to the adoption of the metric system."

Exhibit L.—Specimen examination papers submitted by school children in the city of New York, 12 to 13 years of age, being those of the first, second, and third prize winners in the Herald's metric contest for school children. "That the metric system may be easily and quickly learned even by young children was shown by a contest organized by the Herald, in which 5 test questions dealing with measures of length, volume, and capacity were presented."

If any further proofs or exhibits are desired by your committee in support of the assertions made in my statement I should be glad to submit them.

Very truly, yours,

JOHN W. HARRINGTON.

STATEMENT OF MR. ARTHUR E. KENNELLY.

Mr. KENNELLY. I was born abroad, educated abroad, and am a consulting electrical engineer. I have been engaged in consulting engineering for a number of years, am a past president of the American Institute of Electrical Engineers, and I have been connected more or less intimately with manufacturing for a number of years.

Mr. LILLEY. What manufacturing?

Mr. KENNELLY. Electrical manufacturing. I am at present professor of electrical engineering in Harvard University. I have lis-

tened with great interest to the arguments that have been presented for and against the bill now lying under discussion, and I think that much of this discussion can be eliminated by a general recognition of what both sides may be said to have fairly established. I want, however, to take exception first to one of the main allegations of the antimetric side, that if this bill is reported by the committee and passed by Congress it would set the people of this country, and the engineers as a class thereunder, under a dual system, a dual system which does not exist to-day. I take exception to that statement. I have here a book written by two American electrical engineers residing in England, Messrs. Turner and Hobart. The book was published in 1905 by Whittaker & Co., in London, which firm has also a branch establishment in this country. The book is entitled "The Insulation of Electrical Machines," and the first paragraph says: "The preparation of this treatise on the insulation of electrical machines has been undertaken to render available to engineers some portion of the results of twenty years of practical work with insulating materials, and of careful study of their insulating properties."

This is not, therefore, a book of pure science; it is a book for the engineer and for the practical artisan, showing how to insulate wires of dynamo machines. This book is written exclusively in the metric system, except in so far as it quotes extracts from writers who have written in English measure. Now, I say that this book is evidence to show that we are already in this dual or transition condition, and I say that it is not a question of what Congress shall do now or in future as to whether we shall be in a dual condition. This condition exists to-day, and practical engineers are already laboring under whatever disadvantages pertain to the coexistence of the two systems. All electrical engineers have to be familiar with both systems. Not only does this apply to electrical engineering, but it also applies to a lesser extent to mechanical engineering. I have here a copy of a recent issue of the paper called "Engineering," which is a journal devoted to mechanical engineering in the main. This copy contains a paper in which a part of the units are metric units, printed freely and without any explanation or apology. Now, here is competent evidence to show that we are already living under a duel or transition condition of weights and measures in the workshops, in the manufactories, and in the engineering establishments, and that men have to be more or less conversant with both systems. This bill can only alter that condition in so far as it may aid in bringing the dual system to an end by the universal adoption of the metric system.

I do not wish to intimate that all English or American electrical books are written in the metric system. There were none in the metric system until quite recently. There are evidences of more all the time. That is, the metric system is steadily coming in; it is not going out.

You have had before you in this room, gentlemen, other electrical engineers whose testimony bears out my own, that electrical engineers, as a body, are in favor of this bill. Professor Elihu Thompson, a distinguished practical engineer, who has done more perhaps than any other man for the development of electrical engineering, spoke strongly on behalf of the introduction of the metric system, as you

will see in the record, and you have had Mr. Westinghouse and Mr. Mailloux before you, possibly others. I am not here to represent the electrical engineers officially. I am only here as a single individual, but I can bear my testimony as an individual that the electrical engineers are strongly in favor of the metric system and of its introduction into this country.

The board of directors of the American Institute of Electrical Engineers a few years ago sent in a unanimous indorsement of the then pending bill before Congress, begging this committee to recommend that bill. The committee on units and standards of the American Institute of Electrical Engineers within the last few weeks strongly and unanimously indorsed the same resolution and repeated it, urging that this bill should be reported and should be adopted by Congress. So that one branch of engineering, at least, is already strongly in favor of the metric system, partly for the reason, I believe, that electrical units are metric units. Notwithstanding the representations of other parties, I wish to state emphatically my understanding that the electrical units are metric in their nature and are naturally metric in application; but of course they can be used, by equivalents, in any system—in the English system, for example. Many men to-day employ them in the English system without any reference to their metric application, but they do so by a violation of the electric system and without reference to their natural applications. They are thereby merely digging holes in order to fill them up again.

It has been stated to you by some who are opposing the bill that we already possess here a degree of uniformity in our measures, such as France and Germany set out to attain through the possession of the metric system. Such a position is, I submit, quite indefensible. I happened to obtain the end of a cartridge box the other day [indicating pasteboard end of cartridge box]. This is apparently the end of a cartridge box of the Winchester Arms Company, and it bears the printed statement that the charge of the cartridges is 38 grains of powder and 1½ ounces of shot. The gentlemen in this room are doubtless experts in regard to weights and measures. Their experience on this committee is such as makes them, no doubt, familiar with our weights and measures, but I doubt very much whether any gentleman here can tell the relative proportions of powder and shot in that cartridge from that label without taking pencil and paper and computing it. I certainly can not do it myself without the use of tables, pencil, and paper. What harm has the powder done that it should not be stated in the same unit of weight as the shot, or what harm has the shot done that it should not be stated in the same unit of weight as the powder? This is not an extraordinary case at all. Here we have the same heterogeneity that we find in so many other instances. We have one thing weighed in long tons and another weighed in pounds, and a third thing weighed in ounces, and so on for fourteen different units.

We have here a multitude of bushels, 2 pints, 2 quarts, 2 tons, and a variety of their ambiguous units of volume. There are 18 units now employed in this country that are ambiguous; that is, are susceptible of more than one interpretation in magnitude. Is that the degree of unity which France and Germany secured? Is there any gentleman in this room who will deny the superiority of the American currency system, our decimal currency system, over the English

pound-shilling-and-pence system? It is not necessary to argue that to any body of American gentlemen, but you can not, I believe from experience, convince a body of Englishmen to that effect. It is remarkable how few Englishmen, cultured Englishmen, will admit that the American decimal system of currency is superior and simpler and better; and just as they are blinded by long habit to the inferiority of their currency system, so are Americans blinded to the inferiority of our systems of measure.

Mr. LILLEY. The English will not admit that anything we have is superior, will they?

Mr. KENNELLY. I would not like to say that.

The CHAIRMAN. Do you remember the meeting of the chamber of commerce in Toronto several years ago when they passed unanimously a resolution in favor of the metric system?

Mr. KENNELLY. Yes; and I was in Toronto at that time. There were some 70 representatives present from different chambers of commerce throughout the British Empire, and they reported in favor of adopting the metric weights and measures, and urged the premiers to bring that resolution to the home Government.

The CHAIRMAN. Which they did?

Mr. KENNELLY. Which they did. At this time it is a fact that two of the English colonies have already departed from the English system. These are Mauritius and Seychelles. They are two small and distant colonies, but I quote the statement from the colonial reports of Great Britain. These colonies have thrown off the yoke of the old measures. Do you suppose that any country that adopted the metric system has ever retrogressed toward so incoherent a system as that under which they previously lived?

A BYSTANDER. Those are French islands.

Mr. KENNELLY. They were originally French, but their government, habits, and customs have long been English.

It has been asserted that this bill if passed would cause great expense upon the manufacturers. If that were necessarily true, I should heartily sympathize with the manufacturers, and I should do all in my power as an individual to oppose the measure. I suppose this bill is introduced, not for the consideration merely of the manufacturing element of the community, but for the whole community, and that its interests are to be judged by the effect on the community in general. Nevertheless, the manufacturing section of the community is an important element, and as such its interests should be carefully safeguarded, and anything which would tend to load the expense of a change upon the manufacturers should be carefully avoided. I do not consider, however, that this bill will entail any appreciable hardship upon manufacturers.

It is agreed by the opponents of this measure that if the bill were interpreted in the sense that all existing machines, tools, and apparatus should be strictly described in their actual metric measure—that is to say, if the actual existing size were correctly stated in terms of the meter or appropriate decimal thereof—that the tool which made it would continue to make it, and that there would be no necessity for the creation of any new tools or for the abolishment of any existing tools.

Mr. LILLEY. If you are going to retain that measure, that size, that

dimension, can not you describe it in the existing system more intelligently than we can in the fractions of the metric system?

Mr. KENNELLY. You can perhaps describe it more briefly—i. e., shorter, but that is not necessarily more intelligently.

The CHAIRMAN. That is, that it may be that you can express it shorter?

Mr. KENNELLY. It may be that you can, yes; that is, it might be shorter, for instance, as 1 inch would be shorter than 25.4 millimeters.

Mr. LILLEY. Then if we are to retain the old dimensions had we not better retain the old measurements?

Mr. KENNELLY. Not necessarily, because if you take a blueprint or drawing or parts of a machine you do not now have those parts in even inches. Any given dimension is not generally just 1 inch; but is, say, 1 inch and two-tenths, or perhaps 1.32 inches.

Mr. LILLEY. So you think the decimal system would hit them once in a while?

Mr. KENNELLY. Yes.

Mr. LILLEY. Something would be exactly a meter?

Mr. KENNELLY. Yes; it would sometimes come out an even number. But as it is now, if you take the measurements on any drawing, you find fifteen-sixteenths, or seven-eighths, or thirty-three sixty-fourths, and the finer you have to measure, the more you run into extravagant figures on the existing system. It is only here and there that the sizes of the parts will be an exact number of inches. The more accurate you have to be in expressing the sizes of a machine the more figures you will have to run into in either system. If you want 1 per cent of accuracy you must perforce go to two figures in either system. If you want yet greater accuracy you must go to three figures; it is only very rough apparatus that can be described in even figures, such as 1 inch or 2 inches or 3 inches.

The CHAIRMAN. Ordinarily it would be described in even metric measurements anyway?

Mr. KENNELLY. Yes; as, for example, an inch pipe, which varies considerably in commercial size; that could be expressed by 25 millimeters, instead of the 25.4; one would be just as good as the other.

Mr. LILLEY. Is it not a practice which has grown up in the factories of dividing to decimals, one-tenth or one-hundredth or one-thousandth, does not that overcome the difficulties largely of finer calculations?

Mr. KENNELLY. Decimals tend to simplify it very much—that is to say, all computations with $\frac{1}{16}$ and $\frac{33}{64}$, and so on, must be very complex; but if you express these fractions as decimals you go far to simplify work with them. Of course you get a still greater simplicity if you decimalize in the metric system.

The manufacturers have represented their case strongly on the supposition that the passage of this bill will lead to the insistence by some representatives of the Government upon exact metric sizes, to which their machines are at present unfitted to conform—that is to say, on the assumption that the Government officer is going to demand his pound of flesh, and instead of calling for a 1-inch rod, which would be 25.4 millimeters (not 25.399, as has been represented here), he might call for 25 millimeters. It is true that in such a case the manufacturer would be put to some expense. But the officer, if he were minded to be so arbitrary, could give just as much trouble to the manufacturer to-day in the customary system by insisting on special

sizes. He does not need to be provided with a club in the metric system.

Mr. LILLEY. Is it not the object of the metric system to eventually have them specify 25 millimeters and leave off the fraction?

Mr. KENNELLY. No, sir; I think not.

Mr. LILLEY. Is it not the hope that you will come down to that simple way of expressing it?

Mr. KENNELLY. Not as I understand the matter. The object of the metric system is not to affect things. Things are not to be altered, but only the manner of describing the sizes of things. This particular instrument which I hold in my hand can not be altered by all the measures in the world. It is the way we describe that thing in the metric system that makes it easy to understand and easy to deal with in its relations to other things.

Mr. LILLEY. Have you any idea that if we had always been working in the metric system this particular size would have appeared?

Mr. KENNELLY. We would doubtless have come very close to it.

Mr. LILLEY. Then it is your hope to go to another size?

Mr. KENNELLY. No.

Mr. LILLEY. Then why do you want to go to the metric system?

Mr. KENNELLY. Because the metric system is extremely simple and uses one unit of length instead of 20.

Mr. LILLEY. But in working to the metric lengths you have to go into fractions?

Mr. KENNELLY. Decimal fractions; while in the English system there are not only either vulgar fractions or decimal fractions, but there are also 20 measures of length, from the inch up to the mile, and you can express yourself in yards or in rods, or in feet or in furlongs or in miles. In one line of work it may be customary to express length in inches; you go into another line and it is customary to express length in feet, and then you take a third line and it is customary to express length in yards, but if we have the metric system we do not have that incoherence.

Mr. LILLEY. What has been the result in France and Germany, where this has been adopted; have they still adhered to the old dimensions, or do they specify things now in even units?

Mr. KENNELLY. I am more or less familiar with the practice in France in the machine shops, having visited many and inquired into this particular point. It is customary to express sizes in even millimeters, but where greater accuracy is required they go to decimals of a millimeter. The custom, however, is to employ even millimeters. It has been alleged here in my presence that in France and in Germany to-day, in Europe to-day, they do not use the metric measures. I may say that while I have no expert knowledge of the particular industries which have been described, namely, the textile industries, I know from my own observation that the machine shops of France, Germany, Italy, and Switzerland to-day employ the metric system substantially in every respect. It is as correct to say that other systems are employed in those countries as it is to say that Hebrew is spoken in this country. It is true you will hear Hebrew spoken, for instance, in some parts of New York City, nevertheless English is the language of this country; and so the metric system is the system of continental Europe.

Mr. LILLEY. I want to know if it is not a fact that in the countries that have adopted the metric system there has grown up a system that has brought about a new standard of pipes, a new standard of arbors?

Mr. KENNELLY. That has happened in the course of many years.

Mr. LILLEY. And that is the ultimate result; that is the tendency.

Mr. KENNELLY. In the course of decades.

Mr. BURLINGAME. In regard to whether or not the introduction of the metric system is growing in this country, I asked our storekeeper, who has charge of sending out our tools, before I went away, and while he said the sale of metric calipers and scales in our business had increased, that they had not increased as much as the sale of English tools.

STATEMENT OF MR. ARTHUR GORDON WEBSTER, OF WORCESTER, MASS.

Mr. WEBSTER. Mr. Chairman, I am professor of physics at Clark University and have been there for sixteen years. I do not suppose I need give the names of the different societies I belong to.

Mr. GAINES. You can insert those in the record or give them now. I would like to have them now.

Mr. WEBSTER. I am a member of the American Physical Society and have been president of it for two years. I do not come here to say I represent it, but I think what I say will be agreed to by every physicist in the country. I am a member of the National Academy of Sciences, and I won't go on and load up the record with the rest.

I have listened with great interest for two days to the speakers who are opposed to this measure and I have read the records for two or three or four years. I want to say in the beginning, gentlemen, that there is no more patriotic American than I am. I am a Yankee, born in sight of the Boston statehouse, and I have lived here all my life, except four years when I was in Europe, and nobody desires the continued greatness of this country more than myself. There is nobody who believes more than I do in what Mr. Du Brul has said—that we depend largely on our manufacturing interests and industry for our continued prosperity; there is nobody for whom I have a greater respect than for a good engineer, and I think I can tell a good engineer. We have a great many of them. But, gentlemen, if you will allow me to say one thing, with all the deference and respect we have for the manufacturers, there are other people in the country besides manufacturers. And I notice that the American manufacturer is a very sensitive person; he is very sensitive to change, and the moment he hears the word "change" he comes right to Washington.

Gentlemen, you can not touch the tariff, as you know, with a 10-foot pole but what you have a swarm of people after you. "Don't touch it or we shall be ruined." Here they are. I want to call your attention to the fact. There has been some talk of propaganda by the gentleman from Cincinnati. Who has made the propaganda? I notice in these books [referring to testimony already taken] the same names again and again, and, as the clergyman said of the man who was married the fourth time, and perhaps again. I noticed Halsey, Dale, representing everything; Mr. Towne has been here several times; Mr. Du Brul has been here several times; Mr. Sellers, the last and the greatest authority on their side, who has unfortunately

gone from us, has been here again and again. This is my first time, and I hope you will listen to me.

Mr. GAINES. And Doctor Stratton has been here all the time. [Laughter.]

Mr. WEBSTER. Yes; he has. And I hope he will continue here all the time until the metric system is adopted in the United States, as it is throughout most of the civilized world.

Mr. CUSHING. How about the usage?

Mr. WEBSTER. I am coming to that; don't interrupt, please. I don't think it is necessary to go into history. Quotations have been made from John Quincy Adams. He is dead. He was a good man, and he came from Massachusetts, but he is dead. Quotations have been made from Napoleon. He is dead. Yesterday somebody quoted Julius Cæsar. He is extremely dead. I don't want to cite any of those, but, to get rid of Napoleon and finish with him, I would like to state that he didn't say that the metric system was a failure and issue a decree to that effect, but he said—having probably listened to Mr. Towne—as to the matter of dividing by two—and I suppose everybody in France divides by two, and everybody there has two children—Napoleon said that he would permit—I have the decree here, but I don't want to take the time to read it—he said that he would permit other measures to be used, so far as the names were concerned, not an old pound instead of a new kilogram, but that he would let them call it something else. He said, "You may call the half kilogram so, and the half of that so, and the half of that so," and after they had tried it a quarter of a century they found that nature—French nature—did not demand it, and they said, "No; this is making a devil of a row," and in 1837 they established the metric system in its purity, and they have had it ever since. The French people are a very live people, and they not only make a lot of textile goods—and some of them come to Massachusetts; not cotton, but silk—but they make a lot of other things. They got badly whipped in their war with Germany, and the first thing the Germans did after the peace was made was to take their system of weights and measures. We are not in the dark about Germany. What is it that accounts for their success? Is it the metric system? Partly, but of course not entirely. I can tell you what accounts for their success. Every week I read the papers, as Mr. Raynal does. I read a good many papers in a good many different languages. I expected to be asked whether I was a practical man——

Mr. GAINES. We are finding that out.

Mr. WEBSTER. My knowledge of Europe is not by long-distance telegraphing and correspondence with foreign consuls; neither is it confined to picks and counts of yarns. I have been in Europe, France, Germany, Italy, Austria, and Sweden, and I have been able to speak with the people in their own languages wherever I have been. I lived four years in Germany; I have been a student at the University of Berlin; I have lived some time in France, and been a student at the University of Paris; I have lived some time at Stockholm, and been a student at the University of Stockholm. All of these countries are metric countries. I would like, in the strongest terms, to deplore and deprecate—I will not say deny, although that

is the proper word—the statement made here that these countries are not metric countries. Mr. Monahan admitted that he had never seen, in the course of fourteen years living abroad, anything sold except in the metric system. Mr. Lovering, you say the counts of the yarns are made by the English measure. We admit that those looms were bought in England, and a good many of them are now bought in Worcester, Mass. I will tell you this, that you can not buy ribbon except by the meter or centimeter in Paris. You say it is hard to reckon in. You buy a quarter of a yard. If you ask for 8 inches here they would not give it to you, but in Paris you could buy not only a meter, but a tenth of a meter, or 40 centimeters, or any length desired.

Mr. LOVERING. I am perfectly well aware that ribbon is sold by the meter there, but that does not touch the matter that I spoke of yesterday. I referred to the organization of the pattern, and I contend still that the manufacturers in all the French cities do use the English scale for numbering their yarns.

Mr. WEBSTER. I do not dispute that. That has been put in the testimony by Mr. Dale for years and years, and it is in his book.

Mr. LOVERING. That is the point I made and the only point.

Mr. WEBSTER. But I say in buying and selling the people know nothing about any measure except the meter.

Mr. LOVERING. We don't fall out there at all, but I do say this: That where it touches us here at this moment is that we are obliged by the law of this country to count the threads by the English measurements, and when they come from our custom-house our custom-house officers are obliged to do that according to the act of Congress. This act compels them to change that system. That is the only point I made yesterday on that.

Mr. WEBSTER. Mr. Dale has gone on at great length about the difficulty of counting, which is such an extremely accurate method apparently. I remember when a boy seeing on my father's desk, who depended all his life on textiles, a little plate with a quarter of an inch hole in it, as far as I remember, by which they counted the yarns, and I often used to do it. Mr. Dale says it is impossible to do it in a centimeter. I suppose he never tried. That reminds me, gentlemen, of one thing you have had here, and I would like to say right off that most of your witnesses have talked about whether a thing can be done or not. When you want to find out whether a new thing is a good thing, a good way to find out is to ask the man that has used it, not the man who has never used it and says it will ruin him if he has to use it. A good many of these gentlemen say it will ruin them. I don't think it will. I don't think it will cost as much as they think it will, but I say a good way to find out is to try it. It seems to me the only fair witnesses in that respect were Mr. Raynal and Mr. Monahan, who said they had tried it.

Mr. GAINES. Have you ever built a ship or locomotive?

Mr. WEBSTER. I have worked in a shop and designed tools and made them and that sort of thing, and I could make a locomotive if I had the tools.

Mr. GAINES. Did you ever make one?

Mr. WEBSTER. No; I never did.

Mr. LILLEY. May I ask you a question?

Mr. WEBSTER. Certainly.

Mr. LILLEY. Admitting what you say is true, that your system is an improvement, don't you think that the intelligence of the American public is such that that can be left to them to decide, particularly when they are the ones that are financially interested in it; and do you think it is advisable to convert them by main force or by educational methods?

Mr. WEBSTER. I think persuasion is always better than force, and allow me to say in reply to that that it seems to me this thing is just as much a matter for experts as the matter of the currency. The currency is a thing everybody says can not be touched by a vote of the people; it must be done by experts. We must have a certain standard, the world standard——

Mr. LILLEY. But you do not answer my question. I asked you if you think it is advisable to force the people who are financially interested in this and object to it into something that they do object to?

Mr. WEBSTER. I am speaking of the bill. As far as the bill is concerned, I think it is by all means advisable not only for the interests of the manufacturers, but for the interests of the whole United States. I want to say besides the manufacurers there is the farmer, whom we don't often hear of.

Mr. GAINES. I am one myself.

Mr. WEBSTER. We ought to hear from the farmer. He is an intelligent man. You have asked questions about the difficulty of introducing the system, and whether the people won't have to go to school to learn it. You don't seem to consider that the American people is the most intelligent public in the world. You can not live so far off in the country but what you can get the daily paper. As soon as this bill goes into effect the papers will take it up and will publish a simple explanation about the metric system——

Mr. LILLEY. I want an answer to this question for this reason: There are some of us on this committee who believe with Mr. Lovering that the enactment of this law would compel Mr. Lovering and others to change in some manner their business if they do Government work. We may be wrong. You may have a different interpretation of the bill, but if we put the interpretation on the bill that Mr. Lovering puts, then do you think it is wise for us to compel them to do that which they do not want to do?

Mr. WEBSTER. If you put that interpretation on it, I should say yes, I would like to; and I don't believe it will cost Mr. Lovering one-tenth of 1 per cent of his investment to make that change.

Mr. LOVERING. Are you familiar with the operations of a cotton mill?

Mr. WEBSTER. Reasonably so. Please notice that I have only five minutes left.

Mr. LILLEY. I would be delighted if the committee would consent to give this gentleman more time.

Mr. WEBSTER. I will ask you for five minutes, in which I want to make my chief argument, and then the committee can do as they please about giving me more time to answer any questions.

The chief argument for the metric system is this: It is evident to any person who has considered the matter that the only successful, or the most successful, system of weights and measures is that which conforms to the enumeration system which we use, which is the decimal system. A great deal has been said here about nature. I want to

say that the most natural mathematical operation, and the first one which the child goes through is this: One, two, three, four, five [counting on fingers]. That is the way they do it, and that is how the thing came. We must go by that. It is our natural decimal system. Would any of you ever give it up? Did any of you ever make mistakes in it? No. If you get a bill from a tailor for $600 for a dress suit, you know he has made a mistake—you know it is $60; or if it is for $6, you know he has made a mistake in the decimal point—that it ought to be $60.

Now, Mr. Towne, who has been listened to for the longest time, has a great deal to say about what he will concede; he has made a great many concessions. He says the metric system is a good thing for a scientific man. If so, why not for the rest of you? How does the scientific man differ from anybody else? If it saves time for the scientific man, it will save time for the rest of the country, and saving time means saving money. Money talks. It has talked here to-day. But it is not the only thing that talks. A nation which never hears any other talk than that of money will not be a great nation. You say you will reform the English system. One speaker said he was willing to throw away the pound and the gallon and all the rest, like Artemus Ward, who was willing to sacrifice all his wife's relations in the war. He says, "Give us our sacred inch, but decimalize it." Very well. Do you think for one moment that France and Germany and Italy and all of South America and all the rest of the world are going to adopt the English inch? If you do, I will not say another word in this committee. I have done.

Mr. LOVERING. I suggest that the gentleman be allowed two or three minutes more.

Mr. WEBSTER. I merely want to use Mr. Towne's figures. He says that English speakers are 150,000,000. He says that France and Germany, to say nothing of the metric-using countries, are 95,000,000. That is nearly two-thirds. Gentlemen, will you who believe in rights of the minority, will you suppress the minority, which has been going on so successfully for these thirty, seventy, eighty years, and getting along so well that they are pretty nearly converting us to their views, will you suppress that? Will they come over to you? Don't you believe it.

Mr. DU BRUL. Will you suppress the majority?

Mr. WEBSTER. No, sir. Most of us believe in peace and internationalism and reciprocity and swapping, and I believe in it, but either we shall have Mr. Towne's suggested system or the metric system. He knows what it will be. I know it. Either we shall have that or the two. You in Cincinnati will be having one, and all the rest of the world will be having another. Why does Germany do that and why does she get along? Because what she goes at she goes at with common sense—that is, in a scientific manner—that is the way she adopted her weights and measures. You have only to take up the English papers—the London Times or any other paper—and you see wails. About what? "We are losing our trade." "What shall we do?" "Germany is doing this." Gentlemen, you don't seem to realize that your chief competitor now in machine tools is not England any more. No; England is on the down grade. It is Germany. As England goes down Germany comes up, and you have to fight her, not on the water or with troops, but in competition.

She is going up. Only a week or two ago in London was held a dinner to celebrate—what? Doctor Perkin, the inventor of the aniline-color industry. Doctor Perkin was there. They paid him much honor. And then they said unfortunately England now has no aniline industry. Who has got it? Germany. Why? Because of her scientific methods.

Mr. LOVERING. Free alcohol?

Mr. WEBSTER. Not much. England had the electric business. Who has got it? Germany and the United States. You have to divide it—you can not have it all. What is Germany building her things in? Let me read from a review. Mr. Halsey writes a book about Europe, and here is a review of his book by Mr. Kapp. I do not suppose Mr. Halsey has ever been there. [Mr. Halsey acquiesces.] Mr. Kapp makes all sorts of fun and also writes seriously of these illustrations. This is the celebrated Halsey and Dale book. Among the things he says is this:

On engineers' drawings got out in metric countries I have never seen dimension lines marked otherwise than in millimeters, and I doubt whether German or Swiss fitters could work to a drawing marked in feet and inches. The only parts of machinery where the English system is still used are screws, nuts, nipples, elbows, and such like fittings.

We know all about that.

M. Guillaume, an eminent Frenchman, also reviews this book of Mr. Halsey. He says—

Shall I go further? Shall I advise Mr. Halsey to investigate whether the ruthe, an old German measure, is still used in Geneva, a city where French is spoken, and whether a measure of length is expressed in bushels? Can we accept the translation of the pfundschwer, an old German unit, in terms of the yard? But it will be said that these are simply oversights, and there remain enough units in the table to verify Mr. Halsey's argument. He notes, for example, the instance of 16 separate pounds used in different Swiss and German towns, but outside three of these (a misprint being corrected), which are equivalent each to exactly 500 grams, and formed the transitional unit employed almost everywhere at the outset of the metric system to help in its acclimatization, I can confirm, without fear of contradiction, that no one in the countries or cities he mentions knows at the present time the units which he quotes.

It seems they are equivalent each to exactly 500 grams; they are not different, as Mr. Halsey seems to think; they are all the same; it is merely the name. It does not make any difference whether you call the child John or George, as long as you know it is a boy.

The CHAIRMAN. What pamphlets were you reading from?

Mr. WEBSTER. The Electrical World and Engineer.

Mr. HALSEY. May I say one word about this notice, as long as I have been referred to?

The CHAIRMAN. I think we will not yield for a speech now.

Mr. LOVERING. I would like to ask a question. You said just now that the metric system, or the decimal system, was the natural system, using your hands to count one, two, three, four, and five.

Mr. WEBSTER. Yes.

Mr. LOVERING. I don't know that it is pertinent, but I would like to ask you whether music is not written all over the world in the octavo and not in the decimal system?

Mr. WEBSTER. Well, sir, that is a physical question, but I do not suppose that you would care for a lecture on acoustics here.

Mr. LOVERING. There must be some reason for it. You sound a note and then the octave.

Mr. WEBSTER. I didn't say it was the natural system to count intervals in music.

Mr. LOVERING. You have to have that, and that is used the world over?

Mr. WEBSTER. That depends on physical laws; that does not depend on the mind.

Mr. DEBRUL. There are lots of other things you can not help.

Mr. WEBSTER. You can help these that I am talking about.

Mr. LOVERING. You are aware of the fact, are you, that the octave has twice the number of vibrations?

Mr. WEBSTER. Yes, sir; rather. I have been working on sound principally for the last seven or eight years, and music too——

Mr. LOVERING. I have noticed that for the last few minutes. [Laughter and applause.]

Mr. WEBSTER. That is an excellent joke, Mr. Lovering. It elicits more laughter and applause than anything else that has been said, except the reading of a German name referred to yesterday. I apologize for talking too loud; I have to talk fast on account of my limited time.

Mr. LOVERING. I go back to that question where you said that it would not cost me or any other cotton manufacturer any appreciable amount to make the change. I would like you to show me why that is so.

Mr. WEBSTER. I think I could do that better at your mill in Taunton.

Mr. LOVERING. I will give you in a word what I have to change. I have to measure by the meter; I have to change all my measuring instruments, which cost many thousands of dollars.

Mr. WEBSTER. I don't think you will have to.

Mr. LOVERING. I have to change my measuring scales. Any man that says I don't have to doesn't understand the business.

Mr. WEBSTER. You will have to change some of those.

Mr. LOVERING. It amounts to many thousands of dollars altogether.

Mr. WEBSTER. I might say that any man that said it would cost you many thousands of dollars does not understand the principles of the metric system.

Mr. LOVERING. I want to say this. I am a believer in the metric system, I have said that from the start. I believe it is impracticable to pass this bill and I believe it is impracticable to enter by this step into the metric system.

Mr. WEBSTER. In your opinion what step ought we to take; what step would you suggest?

Mr. LOVERING. You have to give the people the opportunity—in other words, you metric-system fellows have just got to work your game without the help of the Government.

Mr. WEBSTER. Why can we not do what the Europeans have done?

Mr. LOVERING. No; because it is so ineffectual there.

Mr. WEBSTER. You had better go over and see—talk to the man on the street as well as the men in the mills. You talk about cotton; of course I don't know much about cotton and you have got me there.

Mr. LOVERING. We will not disagree one bit as to the desirability of the metric system, but when it comes to forcing it on the manufacturers and farmers I am not in favor of that.

Mr. WEBSTER. This bill does not do that.

Mr. LOVERING. Yes, it does; it is a step in that direction. When you come to forcing it upon the people of the country you are taking a wrong measure to promote your propaganda.

Mr. WOOD. This is not a world's system so long as it is not used by England or the United States?

Mr. WEBSTER. No, sir.

Mr. KNOWLAND. Your contention is for the greatest good for the greatest number?

Mr. WEBSTER. Yes; and in speaking that way I want to speak not only for the United States, but for everybody, and I believe it is for the good of the United States. Everybody in the United States, I believe, will be benefited. I did wish to speak of the time that will be saved to the children in the schools in learning the metric system instead of our present system. That time will be enormous, and the children who are now in the schools are the same people who will be the men in the shops twenty years from now, when you [pointing to Mr. du Brul] are shoved out as too old by the trusts.

A BYSTANDER. How much time would be saved in the schools?

Mr. WEBSTER. I should think at least a year.

A BYSTANDER. You would not have the boys at school abandon the study of the old——

Mr. WEBSTER. Indeed I would. Yesterday, when I knew I was coming here, I thought I should be asked questions, and I asked my boy 12 years old about the metric system. He was lying in bed sick at the time, but not too sick to answer me, and I asked him, "Do you understand the metric system?" "Oh, yes," he replied. "Tell us about it," I said, and he did. He told me what the meter was, all about it and its relation to the liter and its relation to the gram. It didn't take him long to tell me all about it, and yet he has never learned it in school.

STATEMENT OF HON. ROBERT B. ARMSTRONG (FORMER ASSISTANT SECRETARY OF THE TREASURY).

Mr. ARMSTRONG. I came down here to speak from the practical standpoint on this bill, and not with regard to the metric system as a whole. The bill, as I understand it, relates entirely to the Government Departments, and I think there has been a lot of stuff dragged in here that has no business here at all. It strikes me a few practical observations of the workings of the present system would be more to the point than anything else.

Fully three-fourths of the time of the liquidators in the custom-house is now taken in the transposition of the units of the metric system to the equivalents of our system and vice versa. That is true of all the imports except Great Britain and some of its dependencies. The same thing is true in figuring drawback on any importations from the metric countries. Yesterday I had two or three men of the custom-house with me and went over the thing again in order to refresh my memory. If this bill becomes a law, all that will be neces-

sary will be to establish, through the Bureau of Standards, a table of equivalents of the present tariff, carried out with the rates of duties, so that the gallon and other units of our present standard will have their equivalents in the metric system and a rate applied thereto; and that will end all the transposition except from Great Britain. And I may say here that my information from Great Britain is that this country needs to hurry if it is going to beat Great Britain in this matter.

I have studied this matter for a good many years, and I gave it active and practical study while I was in the custom-house. I am not prepared to discuss, and I do not think it is necessary, the question of the metric system as applied to manufacturers and other people. We are talking here about the Government using it, and I am heartily in favor of it, and I believe it would save money to the Government. It would not only save money, but it would prevent a lot of annoyance that now arises in the importing trade. Not so much in the Government goods. They have their equivalents and they can go along; it is simply a question of having the money with them. If the Government wants to keep paying more for this translation, they can do so. But, as you know, the liquidator is the highest priced man we can get. They draw from $2,000 to $2,400 or $2,500 a year. A poor liquidator is worse than none.

I am also a believer in the necessity of adopting the metric system, as far as the Government is concerned, for the facility of export trade, in connection with the drawback provision, which should be enlarged, and in order to take in South America and other Latin countries where our commerce can develop along the lines of least resistance, I am sure that adoption by the Government of the metric system would facilitate the movement through the custom-house, both of exports and imports, with the benefit of drawback. It is only on those points I care to discuss this matter, and if there are any questions I would be glad to try to answer them.

Mr. LOVERING. You are familiar with this bill as it is drawn?

Mr. ARMSTRONG. Yes, sir.

Mr. LOVERING. You are familiar with the collection of duties at the custom-houses?

Mr. ARMSTRONG. I was.

Mr. LOVERING. Can you tell me, please, how under this bill you estimate the duty to be paid on a cotton fabric, in view of this statement. [Referring to the Dingley tariff law.] They say yarns, for instance, and so forth, and so forth, pay 3 cents per pound on all numbers up to and including 15; one-fifth of a cent, exceeding 15 and including numbers 31, 30, and so on. Can you tell me whether it would be lawful for the Government to substitute the metric system for the designation of those numbers?

Mr. ARMSTRONG. There are several schedules in the tariff that the metric system could not apply to.

Mr. LOVERING. About half the matters have specific duties, and wherever there is a specific duty it is put on some such hypothesis as this. Now, under this law, if it goes into effect, can you substitute the metric system without infringing the tariff law?

Mr. ARMSTRONG. There are some schedules of the tariff where we would not be obliged to apply that.

Mr. LOVERING. Would you not be obliged to apply it?

Mr. ARMSTRONG. I am not sure but what that law will require an amendment, but the point is this: A great majority of the schedules of 1897 can take the metric system.

Mr. LILLEY. Why have they not adopted the metric system now in the custom-houses if the object is to save money? Why have not the Bureau of Standards furnished the equivalents?

Mr. ARMSTRONG. They do furnish the equivalents. They furnish the tables, but every invoice comes in in the metric system and it has to be translated back and forth, and that has to be done in the liquidation whereas if the tariff as a whole, so far as the metric system could apply, were translated by the Bureau of Standards and the law said it was legal for them to use the metric system in computing the tariff, one law would cover the whole thing.

Mr. LOVERING. That could be done now.

Mr. ARMSTRONG. Unfortunately it can not be done under the law to-day. Our present standards are observed in the tariff, and it is necessary to go through the translations which I have referred to unless you do something like this to make the metric system legal in the Department.

Mr. GAINES. It is legal.

Mr. ARMSTRONG. I mean to make it mandatory, to enforce it.

Mr. GAINES. Everybody enforces it that wants to.

Mr. ARMSTRONG. There would be a protest against employing the metric system unless there was specific legislation authorizing it.

Mr. LILLEY. Why not let the Bureau of Standards furnish the equivalents and direct your energies to saving the Government money and not put these manufacturers to all this expense in the way in which you are proposing? I understand your argument is practically to save the Government money?

Mr. ARMSTRONG. It will save the Government money.

Mr. LILLEY. Could you not save them money that way?

Mr. ARMSTRONG. No; because if they figured it the other way (in the metric system) to-day there would be a protest.

Mr. WOOD. Do you think it would be necessary to change the wording of some of the schedules?

Mr. ARMSTRONG. I am not trying to give advice to the committee on that point, but my impression is that there should be some provision in here eliminating certain schedules of the tariff where it will not apply.

Mr. WOOD. You think the bill is not perfect?

Mr. ARMSTRONG. I am under the impression that there are certain sections of the tariff where you would have ambiguity.

Mr. WOOD. You think it ought to be amended in order to prevent complications in the Treasury Department and in the tariff schedules?

Mr. ARMSTRONG. I think as a matter of fact you could put this bill through and it would work except in a few schedules, such as textile goods and some others.

Mr. LILLEY. And then the tariff would have to be changed.

Mr. ARMSTRONG. The tariff would not have to be changed; you can not change that. [Laughter.]

Mr. GAINES. You spoke a while ago of a table you had to have when imports came in. What table is that; who makes it?

Mr. ARMSTRONG. The custom-house makes it, I presume after consultation with the Bureau of Standards.

Mr. GAINES. I want the table.

The CHAIRMAN. It is a simple proposition.

Mr. GAINES. So simple I do not understand it. Why won't that table do?

Mr. ARMSTRONG. It won't do because the law to-day specifies certain standards in English weights and measures, and we have to use those.

Mr. GAINES. Can you not get a table that shows the translations from one to the other, and when an invoice comes in you can take it, you know how much is in the invoice and how much tax——

Mr. ARMSTRONG. If you did that there would be a protest, because that says it is in pounds, and so on, unless you legislate to do otherwise. If you legislate you can put in one table and that table can be applied, but it can not be applied until you gentlemen say so. I am much obliged to you, gentlemen of the committee.

STATEMENT OF MR. ALFRED H. RAYNAL.

The CHAIRMAN. What is your business?

Mr. RAYNAL. I am chief draftsman of the Bureau of Steam Engineering, Navy Department.

The CHAIRMAN. What is your profession, if you have one?

Mr. RAYNAL. Mechanical engineer.

The CHAIRMAN. How long an experience have you had as a mechanical engineer?

Mr. RAYNAL. About forty years. I was an apprentice in a machine shop abroad and then went aboard a trans-Atlantic steamer as an engineer, came to this country and made my living here working as a machinist. I then became a draftsman, later on became superintendent of machine shops, and occupied that position in some of the largest concerns of this country—the Delamater Iron Works, for instance, the Richmond Locomotive Works, and the Corliss Steam Engine Works. Was superintendent about thirty years. I am a member of the Society of American Engineers, of the Society of Naval Engineers, of the Society of Marine Engineers and Naval Architects, and other technical societies.

I have listened with great interest to the various arguments offered to-day, but having only just received notice to appear before this committee am hardly prepared to give you any particularly new views. Besides, anyone who has followed the proceedings before this committee in the years past must have noticed that the ground has been pretty well gone over and that there remains but one question, and that is whether it is practicable or not to introduce the metric system into this country. The greatest objection that people who are in favor of introducing the metric system have to meet evidently comes from the shops where machinery is built on the reproduction plan. But, as far as I can see from reading this bill, it is not at all detrimental to such reproduction of machinery. If I understand this bill correctly, it is simply a proposition to introduce the metric system to the people of the United States, where it has not to this day been sufficiently introduced. It is very true that some of our engineers who have been abroad use it to-day occasionally, but without general adop-

tion it does not appear to me that they can have any particular reason for advocating it. Some of the engineers who have spoken against it here I certainly could not quite follow in their reasonings. Mr. Mattice, for instance, says this pipe fitting is an inch and a half T [indicating on table], and says it can not be expressed metrically, or that if the metric system were adopted we would have to change our entire pipe system. I can not agree with him. Our pipe system is not a system expressed in precise inches. Some of you gentlemen are familiar with the pipe business and must be aware that a quarter of an inch pipe measures nearly three-eighths of an inch—nearer three-eighths of an inch than a quarter of an inch.

A BYSTANDER. For inside measurement.

Mr. RAYNAL. Say for inside measurement, if you please.

The CHAIRMAN. There is no doubt about that.

Mr. RAYNAL. You know these facts, and if the metric system were introduced I do not believe that it would of necessity change the piping system.

Mr. GAINES. Do you know from your experience that it will not?

Mr. RAYNAL. Most assuredly; because when I call for an inch pipe I do not get a pipe that measures exactly 1 inch. So if you call it by a metric name you will give it a nominal name, so far as that measurement is concerned, anyway.

Mr. BOND. Those sizes are established?

Mr. RAYNAL. Yes; and I would not change them. You, Mr. Bond, have done a great work in establishing those sizes, and I hope they will not be changed, and I hope and believe that our pipe system will ultimately be introduced in foreign countries. I have listened to Mr. Towne with some amazement when he tells us that the meter is not a practical measurement and that the millimeter is not. Now, I have to measure all the time, I have measured for the last forty years, and I think my testimony in regard to measurements is entitled to some respect, and I fail to see why a man who has a metric rule a meter long has not one of the most convenient measures for ordinary use that can be devised and used, say by the carpenter or the mason, or indeed anybody that wants to make any measurement.

Mr. HALSEY. Why don't the German gardeners use it?

Mr. RAYNAL. I do not know that they do not, but a great many do use it. The meter is nearly the yard measure, and you know that the window-glass or the shade manufacturers present you with yardsticks, and when you go about your house to measure for carpets or other purposes you do not take a 2-foot rule, but prefer to take this yardstick. So I do not think that there is any argument which holds good that the meter is not a convenient rule.

Now, as far as the centimeter is concerned, for ordinary very rough measurements that is a very convenient size for measurement, and when it comes to the millimeter, its divisions can readily be seen with the naked eye. Whether the metric system is a fine enough system of measurement for delicate operations I think has been settled by the testimony of the eminent Mr. Brashear before this committee. You can use it for the finest measurements. There can be no question as to that.

As to my preference for the metric system, permit me to say that I did not use it when I was abroad, because in my day it was not in use in Germany. It was not adopted until long after I had left.

Mr. GAINES. When were you abroad? When were you in Germany?

Mr. RAYNAL. I came from there about forty-four years ago. In this country, where I have received the greater part of my education, I have grown up in the English system and used it almost all the time. The powerful arguments that were put forward by the eminent Coleman Sellers some twenty years ago, when he wrote his first pamphlet on this subject, kept me away from thinking favorably of the metric system; but in later years it has forced itself upon me that we should have a uniform decimal system. On what grounds? First, on the ground of computations. Our men in the bureau are almost constantly employed, I might say fully three-quarters of their time, in making computations, and I think it is undeniable, in spite of the statement to the contrary, that a computation in the decimal system is vastly easier than one in the binary system. The reasons why the binary system is still advocated here has been gone into by the previous witness, Doctor Newcomb, so clearly that it is unnecessary, for me to add anything to any argument along that line.

We practically, however, do not use the binary system, for we make all our calculations in the decimal system. We speak of eighths and sixteenths and thirty-seconds and sixty-fourths of an inch, and using them we are not only very apt to make mistakes, but double transposition takes up a great deal of unnecessary time, and the addition or subtraction in the decimal system is certainly far easier. As far as the decimal points are concerned, on which I have heard a good many statements here, I believe that the exactitude of the thousandth part of an inch, which is mentioned here as something that is wonderfully convenient, can be expressed just as well in the metric system. We express the same thing in the metric system, using only two decimals in millimeters, do we not? There is no difficulty on that score.

Now, as to making drawings for machinery, I would like to call your attention to the fact that we now use not only scales of inches, but many of the various special divisions of inches, and there we have the sixteenths, the eighths, and the quarter of an inch, and so forth; so that our draftsmen have to use many scales, where a foreign draftsman, a German or French draftsman, uses but one. I would like to call your attention to the fact that a little scale, such as they use with millimeter divisions on a sharp edge, is exceedingly convenient to read, and even to approximately subdivide. I may tell you in connection with this that sometimes, in fact, very frequently, people that have not used the metric scale, say, "Is the millimeter fine enough for my drawing? I sometimes use a hundredth of an inch in the scales that I employ." Several years ago, at the Technical High School in Berlin, that very question was raised, whether it might be desirable for the purpose of greater accuracy to divide the millimeter on ordinary draftsman's scales into halves, and in order to settle that question a number of students were given a set of scales divided into half millimeters and the others were given a set of scales divided into millimeters. Then to both these sets of men were given a number of simple examples to measure up certain dimensions, and when they had taken an average of each they actually found that the measurements taken by the millimeter scales were more accurate and were nearer to the actual measurements

as computed than those measured by scales divided into the half millimeter.

A BYSTANDER. Were the measurements in fractions or millimeters?

Mr. RAYNAL. No; not binary fractions, but estimating fractions of the millimeter in decimals.

A BYSTANDER. The measurements were given in parts of a millimeter?

Mr. RAYNAL. There were a number of arbitrary points, say, and they would be measured up by a millimeter scale, estimating any little distance by the tenth of a millimeter and adding up, while the other one had this half-millimeter scale. In other words, they seemed to take very kindly to just that one dimension. The sixteenth of an inch is a little bit too coarse for the ordinary machinist draftsman to use on the board.

Mr. BURLINGAME. As one draftsman to another, I would like to ask a question. In reducing down to scale drawings below the foot, how is work in the metric system made to overcome the difficulties which come in not being able to express measurements except by even millimeters or tenths of millimeters, whereas in the English we can get halves, quarters, and eighths in scaling?

Mr. RYNAL. I haven't had any great practical experience in the use of the metric system in drawing offices except as I used it for my own purposes, and as I read drawings from foreign countries; but I know this much from the carefully obtained testimony from draftsmen that come to us from abroad, that they work to a smaller number of different scales than we do. For instance, they use the full size and the next size, the two-fifths size. They have only one scale which they use, whereas we have a large number. Yours is a very pertinent question. One centimeter to the meter, that is, a hundred, is used; that is very simple. Then they use one-fiftieth, one-twentieth, one-tenth, and one-fifth. The third, the half, the one twenty-fifth are used only on the rarest occasions. In other words, for machinery drawings, for instance, they use practically only one-fifth and its equivalents.

Mr. BURLINGAME. I have charge of a department where we have fifty or sixty draftsmen, and we use that one scale for everything for our mechanical work, and that is, when we have half sizes or quarter sizes we consider the half inch the inch, and when we have full sizes we consider the quarter inch the inch, and right down by the binary system, and don't have to use those complicated scales you refer to.

Mr. RAYNAL. Of course, Mr. Burlingame, I understand your business is somewhat peculiar. It is not the manufacture of large machines. You deal with rather fine machinery, and your men are very much accustomed to transposing the ordinary inch into the binary—that is, half and quarter. We, as mechanical draftsmen in the engineering profession—and I think my testimony will be borne out by other engineers—absolutely taboo the half scale. We have done so for years. Since 1862 I have been at the drawing board and have seen it absolutely condemned since. We do not use it in marine work, in ordinary engineering performances, because it is so misleading. Certain dimensions and certain sizes look so near to the full size measurement that they are very misleading. The quarter size to a practiced draftsman almost actually illustrates the thing before you, and so does the eighth.

Mr. BURLINGAME. And those you can not use in the metric system.

Mr. RAYNAL. Yes; but it is not necessary or convenient.

Mr. BURLINGAME. I brought up this question about scaling down drawings because we have had a number of draftsmen who have worked abroad, and they tell me that that is a source of objection to the system—both our American draftsmen who have worked abroad and draftsmen from the other side who have come over here, they have both said that they can not do that as conveniently as we can in the English system.

Mr. RAYNAL. And I also have asked a great many draftsmen from abroad whether there exists such a difficulty abroad, because I thought this question would be brought up sooner or later, and I wanted to understand whether there were any such difficulties, and I am assured again and again that there exists no difficulty in that respect, and that there is none found in the technical schools, and certainly from the engineers we get from abroad—and they are absolutely familiar with the metric system—we can be certain that the measurement itself has nothing to do with the accuracy of the work. At any rate, I can not see any objection to the metric system in that respect.

The CHAIRMAN. Now, Mr. Raynal, if there are any advantages because of the simple relation between weight and length and volume and weight I would like you to tell us what they are.

Mr. RAYNAL. There are, most assuredly. There are a great many advantages, and we have them brought to our attention every day. To start with, instead of the fact being as stated by one of the witnesses here, Mr. Mattice, and, I think, Mr. Towne, that we have a uniform system, a single system of measurements, the fact is we have a great many measurements. We have different pounds; we have different tons. It is only a few days ago that we received a request from our engineer at Mare Island to please buy certain commodities by the short ton, because they use the short ton out there, while in the East the long ton is customary. We buy some things by pounds avoirdupois and other things we buy by the troy measurements.

Mr. GAINES. That does not hurt you, does it?

Mr. RAYNAL. It is a nuisance.

Mr. GAINES. A nuisance to buy it by a ton and a quart and a pound and, for instance, by the jug. Did you ever buy anything by the jug?

Mr. RAYNAL. That is not the pound, but we don't want to have two different kinds of a jug.

Mr. GAINES. Of course, one is a gallon and the other is a 2-gallon jug.

Mr. RAYNAL. And we want to know exactly what the jug is.

Mr. GAINES. I don't know all about what the jug means, because I am not a manipulator of the jug, from its handle or mouth, but I have bought molasses by the jug, and I have sold corn by the bushel and it has not hurt me; nobody has buncoed me on account of thus selling. Now, what trouble is there in buying by the short ton?

Mr. RAYNAL. If it is stated to be by the short ton, very well, but if it is simply stated to be a ton sometimes you get 2,000 pounds when you ought to get 2,240 pounds.

Mr. GAINES. A long ton is one thing and a short ton is another thing?

Mr. RAYNAL. Yes; if it is specified it is all right.

Mr. GAINES. If he said short tons you went out and got what he wanted, and knew what you were getting?

Mr. RAYNAL. In our naval contracts it is not always mentioned.

Mr. GAINES. It is legalized, and "short ton" called for in this case.

Mr. RAYNAL. I understand the practice is different in different States.

Mr. GAINES. I have seen it in the arithmetic, in Ray's and in Stoddard's arithmetic, and I have never seen any difference between a short ton in Tennessee and a short ton up here. I think we know what a ton is, short or long.

Mr. RAYNAL. The request is on file in the bureau to make purchases by one or the other standard, as there seems to exist no uniform standard between the Pacific coast and Atlantic coast.

Mr. DU BRUL. Is there anything to prevent their doing it now?

Mr. RAYNAL. No; there is nothing to prevent it.

Mr. GAINES. I am trying to get at the pain—I mean physical, financial, or otherwise—that is imposed on you in going out and getting a long ton or a short ton of anything.

Mr. RAYNAL. If you purchase a ton of coal with the idea of getting 2,240 pounds, you don't like to get only 2,000 pounds.

Mr. GAINES. I don't suppose you get full measure when you buy anything from the coal trust; I wouldn't expect to get anything full measure from them; but when you buy from an honest man you expect to get, and do get, full measure.

Mr. RAYNAL. But it is detrimental to the Government, surely, to be fooled that way daily.

Mr. GAINES. How would you improve matters by adding a metric ton to the long ton and the short ton and making three tons instead of two?

Mr. RAYNAL. If that were the legal measure understood all over the country, then you would be sure you would get the one thing.

Mr. GAINES. Isn't the short ton legal now?

Mr. RAYNAL. Isn't the long ton legal?

Mr. GAINES. Yes; but you said he didn't call for a long ton; he called for a short ton.

The CHAIRMAN. I don't think we have much difficulty in understanding that. If there are any further advantages growing out of the relation between length, and volume and weight, I would be glad to have you state them.

Mr. LILLEY. You wish to be understood to say that there is a confusion, that there are two different kinds of tons? There is that confusion; there is no question about that.

Mr. RAYNAL. Because neither the long ton nor the short ton was specified.

Mr. GAINES. I understood you to say that the short ton was specified.

A BYSTANDER. How is another ton going to make it any better?

Mr. RAYNAL. If a ton is understood to be one definite measure you will buy by that ton. The question of corelation of measures of length, surface, capacity, and weight is certainly one of great advantage. We all know that tenth of a yard measures so much, but we do not always deal in measurements that are a yard long or in

subdivisions of the yard or the foot; nine-tenths of our calculations deal in inches.

A BYSTANDER. How are they measured any easier in the metric system than in the English system?

Mr. RAYNAL. Addition and subtraction, and so forth, I don't think that can be disputed.

The CHAIRMAN. Proceed.

Mr. RAYNAL. I want to state to you gentlemen that the draftsmen in our bureau, for instance, make all their calculations on sheets that are filed and kept for record, because it is an important matter at times to find out how our designs originate, and if there is any error found we like to know what it is based upon and how this error, if there is one, was created, and for other reasons. If a man, for instance, designs an engine, all calculations for this engine are filed away together and put so that they can be readily reached. Going over one of these files the other day, a book about an inch thick, I turned over page after page and I didn't find any sixty-fourths or thirty-seconds, or anything of that kind; whenever there were fractions of inches they were transposed into decimals and the whole calculations were made in the decimal system.

Mr. LILLEY. That was when you were trying to get fine work?

Mr. RAYNAL. All our work—that is what I am trying to make clear to you—the practical daily work that we are doing to-day is actually done in decimals.

Mr. HALSEY. Tenths of inches by the Government, but not by anybody else.

Mr. RAYNAL. The point I am making is that for making computations you have to go into the decimal system in order to get along.

A BYSTANDER. Independent of the unit you use?

Mr. RAYNAL. Precisely. But, of course, so far as the unit is concerned, every man can have a preference.

I would like to mention another point which is to my mind rather important. It is customary for us to have a great deal of spread-eagleism about us; we think we are "it"——

Mr. LILLEY. Who?

Mr. RAYNAL. I say "we;" all of us, you and I, I am a United States citizen as well as you are and have been for forty years, and have voted, although I can not vote now. As I was about to say, we have too much of the spread-eagleism. I really think we should look about us a little more and see whether we could not improve our condition by our commercial relations with others, and in the practice of my profession I have come across a rather peculiar circumstances which I would like to bring to your attention. I read about three foreign journals regularly, if not more, but at least three in three different languages, and out of them I glean information that to me is invaluable. I can read the proceedings of German engineers, and French engineers, and to some extent the proceedings of Italian engineers, and when I compare what I find in the American journals I find to my regret that there is but little of that valuable information that gets into our technical journals and when it gets there it is filtered through the hands of England first. Of late—and I think Mr. Suplee can bear me out, for he is a man who follows similar subjects, as his writings show—the Germans have made wonderful strides in the building of machinery, especially naval machinery.

The last year's record of the proceedings of the naval engineers in Germany contains to my mind two most valuable papers that were ever written on screw propellers and ventilating fans, matters that concern us vitally, and yet to this day they are a sealed book to America and they will remain so unless we have the metric system. Why can not we translate these articles? Yes, we can translate them, but while it is a comparatively simple matter to translate plain running text, when it is all interwoven with quotations of figures with whole pages of formulæ and tables, it would take days; and although I have been asked again and again to translate such papers I have not the time—the day is not long enough. And worse than that, unless we are constantly in that business and think metrically all the time it is not familiar to us. It is a peculiar thing, this working and talking and imagining in the metric system. When you stay at it for a day or so it grows on you in such a way that you are thinking in it and you know exactly what 24 centimeters are; you know what 3 or 4 millimeters are; you have it right away; you are not confounded as we are with our gauges; but you all know this.

When I mention to you boiler tubes, and ask for their areas inside or outside, this question of thickness by gauges comes up, and it is a nuisance, and there is not an engineer that won't stand up with me and say we ought to abolish this gauge system. But can we abolish it under the existing circumstances? I believe not. The question is, Can we abolish it by adopting any other system not the metric? Gentlemen, that baby is not born yet; there has not been a single system proposed, seriously entertained, that has a corelation of measurements based on the English system. If there were, we might investigate it, but it has not been born; it is not there. The question whether we ought to go into a duodecimal system is too far removed. But, on the other hand, we have this metric system, which works well. It works well, we know, for there have been ships built with it that have beaten all the other ships that were built on the English system.

The CHAIRMAN. I wanted to ask you especially about this: Whether there is anything growing out of this simple relationship between lengths and volume and weight to give an engineer, for instance, a clearer conception of his work?

Mr. RAYNAL. Most assuredly, Mr. Chairman. I think that a man will think freer. I think that, with you, I have been harassed from the very days that we learned to think in the English measurement; I don't think we have the freedom that the foreign engineers have got in thinking and preparing for our constructions, and I say it with hesitancy, but I tell you it is pretty hard to cope with foreign engineers on actual figures, where they have merely to strike off or add a few decimals, while we have to divide by 144 and multiply by 12 and divide by 16 and use such incongruous measures, drawing off our minds from the principal subject-matter.

A BYSTANDER. And the sliding rule.

Mr. RAYNAL. Yes; what else is that but decimal?

Mr. LILLEY. You say that you appeared here upon notice. Did you come representing the Department?

Mr. RAYNAL. No, sir.

Mr. LILLEY. Do you know the attitude of the Department toward this?

Mr. RAYNAL. Hardly; except in a general way.

Mr. LILLEY. Then you represent your own opinion?

Mr. RAYNAL. Just my own opinion only, sir.

Mr. LILLEY. You say that in the threads upon the bolts we have established a system that will not be changed and you hope will not be changed, and you complimented this gentleman over here for having been instrumental in helping to accomplish it. Now, that is based upon the inch?

Mr. RAYNAL. Yes.

Mr. LILLEY. So many threads to the inch?

Mr. RAYNAL. Yes.

Mr. LILLEY. Now, can you ever express that in the metric system without fractions? Can you ever express that without fractions? If you were to order and use the metric system terms could you order such a thread on a bolt like that without using fractions of some meter or some metric term?

Mr. RAYNAL. May I call your attention to the fact that we use to-day, for instance, 11½ threads——

Mr. LILLEY. I know; but can you ever——

Mr. RAYNAL (continuing). I understand your question and I was going to answer it. That is true, and I am hardly prepared to answer you directly what the stand of the engineers in that respect should be; but as there has not yet been established a metric standard that seems to be universally acceptable, I believe that it is perfectly feasible to use and to continue the English standard bolt and thread with a nomenclature properly adapted to the metric system, just the same as I would not dare to change and touch the pipe system. In other words, what difference does it make to you whether we call that an inch pipe or a 24-millimeter pipe?

Mr. LILLEY. Not any, but look here; you will be making other sizes smaller and larger, and the standard thread will grow smaller or larger as the pipe increases or diminishes in size, and all the while you are making your figures for that in the metric system you will have to be doing it really and truly by the old system, the English system, will you not?

Mr. RAYNAL. For the time being, anyway.

Mr. LILLEY. When are you going to change that thread and put it into the metric system? Until you do that, if you maintain this standard which he has introduced, which says so many threads to an inch, according to the size of the pipe——

The CHAIRMAN. That is not so.

Mr. LILLEY. As I understand the standard, the size of the thread increases or diminishes according to the size of the pipe. Is that true?

Mr. RAYNAL. Several numbers of pipe have one and the same thread; there is a large number that have fourteen threads, then comes eleven and a half, and then eight.

Mr. LILLEY. And they would have to be retained.

Mr. RAYNAL. I believe they should be retained, but that is a personal belief with me.

Mr. LILLEY. But would it not be easier, now, so far as that is concerned, to make your specifications in inches that were the basis on which the result was obtained, than to use metric terms in that particular instance?

Mr. RAYNAL. In that particular instance, no; but it would be better to retain it——

Mr. LILLEY. Going a little further, is that the only standard that has been established that is going to be retained? Are there not hundreds and even thousands of them in the same situation, that must be retained?

Mr. RAYNAL. No; I only know of the pipe standard and the bolt standard that I would retain.

Mr. LILLEY. Have you made sufficient study so that you can say that those two items are the only ones that there is any necessity for remaining?

The CHAIRMAN. We used to hear about twist drills and we don't hear about them now.

Mr. LILLEY. No; but the machinery that makes the thread and the bolt is to be retained according to the same sizes.

Mr. RAYNAL. Yes; most assuredly the machinery is not to be changed a particle. I don't believe that because, for instance, the Government works should ask for machinery in the metric system that the lathes, the planers, the shapers, would have to be changed. I have heard the statement made to-day somewhere that thousands of dollars' worth of machine tools would have to be thrown away or changed about.

Mr. LILLEY. That is what I want to hear about.

A BYSTANDER. Could you cut a metric screw?

Mr. RAYNAL. Supposing we do not use the metric screw?

Mr. LILLEY. Suppose we do not use the metric system at all, if you can say we will not use it in these cases——

Mr. RAYNAL. No; that would not be logical, because the change of the screw thread is not called for and is not necessary, and it is not necessary to change the screw threads for the present. There is no need for it, because you can measure them just as well with the metric rule, and you can establish just as well a standard bolt system with the metric nomenclature as you have established the pipe system with the nomenclature of the inch—while it is not the inch.

A BYSTANDER. How well has the new standard that they are trying to establish with screws in the metric countries succeeded. They have not succeeded, have they?

Mr. RAYNAL. They have not succeeded, and I think it will be quite a while before they will.

Mr. DRESSER. Suppose they do away with the thread pipe entirely and use a plain end pipe and unite it with a coupling that you do not need any threads on.

Mr. RAYNAL. I think we will have to retain the thread pipe for a while.

Mr. DRESSER. Not at all——

Mr. RAYNAL. You are probably aware that in our piping system in the United States Navy on board vessels we avoid the threaded pipe. We make either the flanged joints for copper or steel pipe, or we try to get the welded steel joint.

Mr. GAINES. Reading now from one of your companions, Naval Constructor J. H. Linnard, page 168 of the hearings of 1902, I find he says:

The natural tendency of the human mind is to divide things into symmetrical halves in the common operations of life, and the decimal system of numeration

does not permit you to do that with facility. Nor does it permit you at all to divide things into thirds, which is natural division when halves are not adopted.

He does not agree with you; he is not a metrical system man. Do you agree with him that the natural tendency of the human mind is to divide things into halves?

Mr. RAYNAL. No; I do not. Do you have any difficulty, may I ask you, in dealing with your dollars and cents because you can not subdivide after you get to the half and quarter?

Mr. GAINES. We do subdivide.

Mr. RAYNAL. You do not go farther than the quarter; you don't go into 12½ cents.

Mr. GAINES. Your mind runs in tens, instead of halves and quarters?

Mr. RAYNAL. Not necessarily; however, I have no difficulty in subdividing into tens.

Mr. GAINES. Very well. One other question. In the same hearing, page 73, Professor Newcomb uses this language:

The advantage would simply be that of simplicity. I do not know that, going to market, there will be any great advantage, unless we get it in the way of weighing potatoes, for instance, by the kilogram instead of by the bushel. So far as everyday purposes are concerned, I do not know of any particular advantage, but I am not an authority on the subject and can not say very definitely.

Now, he is speaking about the metric system not bettering the condition of the plain people, and he used a market metaphor to explain it. He is not an expert, he confesses; he says it would not be of any great advantage to the great body of the people. What do you say about that—would it be any greater benefit to them to adopt the metric system? Are they not satisfied and happy and getting along all right?

Mr. RAYNAL. No; I do not think they are happy.

Mr. GAINES. You do not?

Mr. RAYNAL. I do not think they are very happy with their gallons and pints and quarts, and all these various dimensions. I think they would be a great deal happier if they had a meter.

Mr. GAINES. The great mass of people are satisfied with their weights and measures.

Mr. RAYNAL. "Where ignorance is bliss"——

Mr. GAINES. Do you think the great body of the American people are ignorant?

Mr. RAYNAL. No; but if they don't know about the metric system, how can they know whether it will be of benefit to them or not?

Mr. GAINES. Well, if it was hurting them and pinching them they would cry out against it, would they not?

The CHAIRMAN. I was going to say——

Mr. GAINES. I would like an answer to that. If this present system of weights and measures was oppressing to people they would ask Congress to change it.

Mr. RAYNAL. Not necessarily.

Mr. BOWERSOCK. The question was asked a few minutes ago: Because, under laws as they now exist, you are permitted to use the metric system, why have you not done so?

Mr. RAYNAL. Because the engineers—I can speak specially for the naval engineers—are at the present time totally indifferent to the

subject. If they used it and had occasion to use it and used it once, I think they would decidedly favor it.

A BYSTANDER. What proportion of engineers have you working on your computations as compared with the total number of mechanics that are building the battle ships and using computation in the building of battle ships?

Mr. RAYNAL. That has no weight because the men will use either one or the other system. Do you suppose we had any difficulty when we had the decimal system in one and the same shop? I worked in the Corliss shop where they used each system, they used the tenth of an inch and also the binary system.

Mr. GAINES. They used the inch?

Mr. RAYNAL. Because that was our standard.

Mr. GAINES. You did not have two standards; you had two divisions of it.

Mr. STILLMAN. I understand that those of us who want to submit statements in writing will be allowed to do so, as there are a good many of us who have waived putting in a personal appeal. I understand that we will be allowed to file statements within the next ten days in writing.

The CHAIRMAN. Yes.

(Thereupon, at 4 o'clock, the committee adjourned.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
Thursday, April 4, 1906.

The committee met at 10 o'clock a. m., Hon. J. H. Southard in the chair.

Mr. GAINES. Mr. Chairman, I referred to a Mr. J. A. Wood, an architect, with whom I had a conversation. My morning mail brings me a letter from him, dated April 4, 1906, which I ask be printed. It is an important letter.

I also have another letter which I will hand to the clerk and ask to be printed, from Mr. K. E. Keller, vice-president of the Westinghouse Machine Company.

The CHAIRMAN. If they are important letters there will be no objection.

Mr. GAINES. I consider them exceedingly important.

The letters referred to are as follows:

[The Westinghouse Machine Company, East Pittsburg, Pa.]

MARCH 12, 1906.

Hon. JOHN W. GAINES,
Committee on Coinage, Weights, and Measures,
House of Representatives.

DEAR SIR: I understand that the compulsory metric bill is now under consideration by your committee. We again wish to place ourselves on record with you as being unalterably opposed to this bill. We believe that such a law would cause most unjust and unreasonable loss to manufacturers, due to the enormous cost of changing drawings, patterns, tools, and equipment, to say nothing of the infinite loss in business while such changes were in process. It would be a sad commentary on the intelligence of our legislators in

Congress to permit a few scientists and misguided parties to bring about a compulsory metric system that would be enforced upon manufacturers where the cost would be so great and the benefits almost entirely negligible. I sincerely trust that the appalling results of such a measure are sufficiently apparent to you to insure your doing everything possible to defeat the efforts now being put forth in favor of this bill.

Yours, truly,

E. E. KELLER,
Vice-President.

NEW YORK, *April 4, 1906.*

Mr. J. W. GAINES, *Washington.*

MY DEAR MR. GAINES: It was my intention to write you before this, but business has prevented.

Regarding the proposed metric system for this country, I wish to say that I am as conversant with the metric system of measurements as with the English system of feet, inches, etc. I have used it in making plans to be used in Spain, Belgium, Cuba, Brazil, and Buenos Ayres, because the laws of those countries recognize that system in government affairs, and in municipal regulations regarding building.

In employing foreign draftsmen brought up to the metric system and accustomed to it, I find their work contains more errors than when plans are made on English scales. It is the same with the English and American draftsmen who work on metric scales.

The object or unit—the meter, which is more than three times the length of the foot—is too large to be comprehensive when divided into small parts like one thousandths or one ten-thousandths, and is confusing to very clear-minded draftsmen and mechanics, so much so that in Spain and in all the Spanish and Portuguese countries, with which I am familiar, the workmen receive the general plans as they are made, but in doing the work first reduce and make the detail or working plan to a scale of feet and inches (piculs and pulgadas) and yards (varas). Usually, but not always, Spanish feet and inches, are one-twelfth shorter than English feet, while nearly all machinery in those countries is required by the users to be measured in English feet and inches.

In Germany the workmen clung to the feet and inches until despotically they were forced to use the inferior system.

In this country some surveyors divide the foot into tenths, and the average citizen infers that this means metric and acquiesces.

As you are doubtless aware, to express a foot or an inch in metric requires at least five figures, and as the signs in the metric are repetitions, as $'$, $''$, $'''$, $''''$, there are too many chances for errors.

One of the wise provisions of the English system is that every different measurement or division is known by a different name, and thus avoids confusion. A spade is a spade and a shovel a shovel; an inch or a fraction thereof, then a foot, a yard, a rod, a mile.

In land survey in Spanish countries I find many errors, and on close investigation I find they are nearly always tenths, hundredths, etc.—the result of a decimal—an unlimited decimal extension or system.

The decimal money system is so limited as to be readily comprehended, and therein is its great merit. It stops at 100 cents and

becomes the almighty dollar. After that the decimal is supplanted by multiplication without much regard to the metric methods of calculation, and I doubt if the metric system would improve the present methods of division that are said to exist without our special legislative authority.

Much inconvenience to 99 per cent of the native mechanics of the country would be the result. The same would be the case with all land surveys.

The law would be a dead letter in both cases, the same as it is in Spain and Spanish countries, and to a great extent is still in Germany. The feet, inches, yards, rods, miles, etc., will continue to be the measures in general use, no matter what Congress does or what Teddy promises to do.

It is very easy to understand that foreigners that have goods to sell here, and their representatives—also the few manufacturers here that send goods to foreign countries—and the cheap foreign professors that would inaugurate all kinds of bunco "colleges" and systems to promote knowledge of the system authorized by Congress; also the few dealers in mathematical instruments, rules, tape measures, scales, text-books, etc., for schools, colleges, and Government Departments favor it. It would be a good thing for them; would help to place foreigners at an advantage and native citizens to a disadvantage, and the country to a very great cost for a retrograde system—something that is not wanted by any fair-minded man or woman. The whole purpose is one of selfishness and greed.

As a matter of national pride the system we use should be preserved, and propagated as well, because it is the best. England, the greatest country of modern times, finds it so. If recent importations of immigrants can not accommodate themselves to it, they should remember that they came here unasked and to their returning there is no restraint.

The English system is simple—anyone can learn the use of a scale rule in half an hour and most people can learn it in five minutes. While I think if you will take a triangular metric scale rule (the German is the best) 1 foot long, containing 12 scales, and take two drawings made each to a metric scale properly marked, that not one Congressman in twenty can find the correct actual metric dimension unless he has been educated to its use. This being the case with gentlemen of superior education and having superior opportunities, the difficulties to be overcome by the great majority of workmen is easily understood.

It is safe to say that if the metric system was carefully explained to the mechanics of the United States and a vote taken as to its enforcement that it would not get a vote of 5 per cent of the native and naturalized foreign mechanics combined.

One New York newspaper alone seems to be advocating this matter. The names of the people it claims to support the scheme are mostly foreign. The array of professors that it quotes reminds one of the professors that wrote recommendations and certificates of the wonderful cures effected by using blue glass for sun baths, which, like a certain special method of piano tuning, has passed into history.

Hoping you will excuse the great length of this and the consequent intrusion on your valuable time, I am, your most obedient servant,

J. A. Wood, *Architect.*

The CHAIRMAN. The affirmative have one hour and forty-five minutes remaining and the negative one hour and forty minutes. Before proceeding with any other gentleman, I would like to ask Mr. Raynal one question, if he will permit me, and I will recognize him for five minutes to answer this question and any others that may follow it. The question is, whether in your judgment the adoption of this bill or the enactment of it into law would cause a change of tools in the navy-yards?

Mr. RAYNAL. It might, possibly, in the case of some small tools; but in the general and large machine tools I can not possibly see that it would call for any change. It would not call for a change in our planers; it would not change our shapers; it would not change our milling machines, our presses, our lathes, unless there should be metric threads required, and were they required the lathe would not be changed except perhaps by adding another change gear or putting in a new lead screw. But I do not understand that that is within the scope of the present bill.

I do not believe that the present bill means that we shall change to some metric thread that has not even been determined as yet. I believe as far as the thread business is concerned that for the present, probably for a long time to come—maybe forever—the present system of bolt threads will be retained and a nominal size for bolts be adopted, just the same as we have it in the pipe-fitting system. I would like to refer to that again. When Mr. Mattice, a brilliant engineer, comes before you gentlemen, most of you lawyers, and tries to impress you with the fact that all the pipes will have to be changed I would like to ask if you are not aware of the fact that this one and a half pipe does not measure 1½ inches, inside or outside? You may not have in your mind that one-point-five is an inch and a half, but you know that a dollar and a half is $1.50. This pipe fitting is not 1.5: it is one-tenth of an inch out. That is the point I want to bring out. And so with our bolts. We would leave our inch bolt as it is. How easy it would be for the Bureau of Steam Engineering, for instance, to print a new table of its bolts, in which, for instance, the 1-inch bolt would be called the 25-millimeter standard bolt. We would know it would measure 25.4 millimeters, or something like that.

The point is that the actual sizes would be retained. Just the same as we now mark on our drawings an inch standard pipe we would mark the 25-millimeter standard bolt. Just the same as our bolts to-day vary actually from the dimensions as expressed in the standard sizes, so under the metric system it might be the same way. We would not have to express the exact sizes in long decimal fractions. On the larger dimensions especially there may be a slight variance from the expressed sizes. In other words, if I interpret this bill correctly, it is not that we shall change our system of bolts, but simply that we shall call for the machinery in metric terms, the nearest approximate units.

Mr. GAINES. Does a metric inch cover less space than an English inch?

Mr. RAYNAL. I don't quite comprehend the question.

Mr. GAINES. Does the metric inch cover less than the English inch?

Mr. RAYNAL. There really is not any such thing as a metric inch.

The CHAIRMAN. There is no such thing?

Mr. RAYNAL. No; there is an equivalent in the metric system for the inch.

Mr. DEBRUL. You said you would call an inch standard pipe a 25-millimeter pipe. Is 25 millimeters less or more than an inch?

Mr. RAYNAL. That pipe would be slightly larger than 25 millimeters—25.4.

Mr. DEBRUL. The 25.4 would be smaller.

The CHAIRMAN. The gentleman's time has expired.

Mr. CUSHING. My name is Cushing; secretary of the National Association of Manufacturers. Could I say a word for the opponents of the bill? You have before you a schedule of our witnesses, Mr. Chairman. The time to be allowed each witness has been agreed upon among ourselves, the total time conforming, of course, to that allowed us, and it would be a very great favor if the chairman of the committee would stick to that schedule for us, and we should be obliged if when a witness has come to the end of his time he might be called to order, and we also request that all of the time allowed our witnesses according to the schedule should be accorded to them without interruption by anybody. We ask that as a particular favor.

The CHAIRMAN. As far as the committee is concerned, I can not say that a member of the committee can not ask a question.

The committee will be in order. I will recognize Mr. Seaman for five minutes.

STATEMENT OF MR. WILLIAM H. SEAMAN.

Mr. SEAMAN. I am employed in the United States Patent Office. I have been a professor of chemistry for thirty years in Washington, D. C.

Gentlemen, there are a few points which I would want to make as regards personal experience in this matter, because I see that that is what attracts the attention of you who are here to get information. For thirty years I have been a teacher of chemistry in Howard University, where the people are not supposed, who come there for study, to be unusually intelligent. In the laboratory we use nothing but the metric system, and after two or three lessons the students use the metric system and nothing else continuously throughout the course, and I want to say that people learn measures by measuring things with some particular scale, and when they use the scale for measuring things it does not take them very long to know it, and there is not anybody of ordinary intelligence who can not learn the metric system very easily and quickly, and it is a slur upon the intelligence of the American people to say that they can not learn the metric system in a very short time.

Anybody can learn the metric system in the course of four or five hours, if they will set themselves to do it, because the units are so simple, the factor is uniform, so that it commends itself to the intelligence at once as being the most simple and practical system of measurement possible to be adopted. Here is the measure of volume that we use in the laboratory [indicating glass measure]. Here are the measures of weight [indicating set of weights] used with the apothecary's scales. Here are the papers which are used in instruction

[indicating]. Anybody who wishes one can have one. I have a number of copies here which I will leave with the committee. There is a picture of the weights, so that they can see at once when they look at them just exactly what the sizes of those weights are [indicating]. Now, so much for the possibility of learning the metric system. This is from thirty years' experience, during which 2,000 students have passed through my hands. It is not fair to say that the average intelligence of the American public is below the intelligence of these students.

When I commenced the study of chemistry the metric system was almost unheard of in this country. The point has been made by the opponents of the metric system that it has not made any progress in the last fifty years.

The metric system fifty years ago was unused, except in a few portions of Europe and as an academic subject of study. During that fifty years the metric system has become absolutely supreme throughout the world in certain departments. I want that noted carefully. It is supreme in every pharmacopœia in the world. The English pharmacopœia adopted it at its last revision, two years ago. The metric system in a few years will be the only system in the practice of pharmacy and medicine. It is making its way in this country and in England, where the British Parliament abolished the apothecaries' weight ten years ago. It is true that the physicans there still use it somewhat, just as the physicians of this country use the old system, but it is not the system of the pharmacopœia, and it is not the system that would be appealed to in a court of law in a case on trial. The metric system has absolutely the sway in all branches of electrical engineering. Electricity as it is known now was not known fifty years ago. The metric system is in the laws of the United States—it is in all those laws relating to the measurements of electrical engineering, and relating to the coinage, and in other places I might mention. Fifty years ago there was no such thing as the metric system heard of in the laws of the United States. Such a hearing as this would have been impossible twenty-five years ago, because the advocates of the metric system had not attained sufficient strength to make their ideas of sufficient importance to compel Congress to listen to such an exposition of their ideas upon the subject as we have had before this committee. I call that progress.

The metric system is supreme in every university and college in the land. There is absolutely nothing in the laboratories of these colleges but the metric system. If a man is going to know the theory of engineering, if he is going to the original sources of information, he must go to the metric system. There is not any essential progress in theoretical science made to-day in which the metric system is not the foundation of it, absolutely. When Professor Rowland, of Johns Hopkins University, who was the foremost man of physics in this country, produced those marvelous papers of his where he stood on such a height that no one else could get near him, did he use the English system? No, sir; almost without exception they are in the metric system. Did Professor Thurston, of Cornell University, adopt the English system as the foundation of his marvelous store of knowledge? No, sir; he was one of the foremost advocates of the metric system in this country. I tell you that one of the greatest factors of the successful study and develop-

ment of the workingmen is access to the original sources of information; and they can not go to the original sources of information and get their theoretical knowledge which is absolutely necessary to success when they are not familiar with the metric system, and the result is that in your factories, in your workshops, when you want a man that has a thorough knowledge of the business, in most cases you have got to take a German; you have got to take a foreigner, who has received his education in the metric system.

There is not any greater handicap upon the young American mechanic to-day than the ignorance of the man who comes from the common schools and who has not gone through a college and obtained a knowledge of the metric system. They are ignorant of the metric system, and thus they are incapable of getting the knowledge that they require for further progress from the original sources of that information. You say that the metric system has made no progress. Since I have been in the Patent Office I have had exclusive charge of the highest department of work in chemistry—the manufacture of dyes, the manufacture of synthetic medicines, and substances of that kind. On dyes alone the United States has issuel about 1,000 patents. In the synthetic department, which is known as carbon compounds and a great variety of substances, most of them not medicines, there have been issued about 800 patents. There is not one-tenth of these patents that contains any reference to the English system. They are all in the metric system. There is no man who can read those patents correctly unless he knows something of the metric system. In the science of chemistry there is not a single text-book to-day that is not in the metric system. Here is a book which has received the largest sale, perhaps, of any text-book on chemistry, Barker's Chemistry, and there is not a single measure but the metric system in that book. You say that the metric system is not in the textile industry. Dyeing is a part of the textile industry. Here is a book of the highest authority to-day on the subject of bleaching. This is all in the metric system.

(Mr. Seaman here read an example from the book referred to.)

WASHINGTON, D. C., *April 9, 1906.*

Hon. J. H. SOUTHARD,
Chairman Committee on Coinage, etc.,
House of Representatives.

DEAR SIR: At the hearing on metric system on Thursday some one I supposed had charge of the metric side told me I was allowed ten minutes, and when I was called you gave me only five, so I could not make my point intelligible.

It was, first, that the average citizen could learn the system readily as soon as he began to use it, as shown by my thirty years' experience.

Second. That dyeing is a part of the textile industry, and that the metric system is in most of the dyeing books and is in all the patents on dyes, so that a dyer must know the system now.

Third. That the actual use of the metric system in all our higher institutions of learning, and in technical work in England and this country, more than offsets any residual use of old systems in metric lands.

What I heard of the discussion seemed to me too loose and general to be good evidence. If any definite progress is to be made in this

matter it must be better analyzed than it was so far as I heard it. It seems to me issues should be formulated somewhat as follows:

I. Is it desirable to have an international common language of measures? Most people admit that it is desirable.

II. Is the metric system intrinsically better than the British? Most people admit that, theoretically at least, it is.

III. Should the question be regarded as international or national only? All intelligent and unbiased people adopt the first view.

IV. Has the metric system made any progress in the last fifty years? Undoubtedly it has made great progress.

V. Has this progress been toward becoming an international system? It has.

VI. Has any other system any show of becoming international? No.

VII. Is any other system but the British now competing with the metric? No.

VIII. Is the British system itself giving way to the metric system? Yes; New Zealand has adopted the metric system this year. The present Parliament would have adopted it but for a new election.

IX. Are the people who oppose the metric system generally acquainted with it? No.

X. Do most people who advocate it know it and use it? Yes.

XI. Have the countries adopting it found the change so expensive as is asserted? No: the change was made without any difficulty.

XII. Do these countries generally use it in the affairs of common life? Yes; statements to the contrary are absolutely untrue.

XIII. Do the sales books of makers of scales, measures, etc., show metric sales increase? Very greatly and continuously.

XIV. Would the business of makers of measures, etc., be increased by the change? Very greatly; many new measures would be needed and old changed.

XV. Would the manufacturers lose money by the change? No; they would make the consumer pay any additional cost, and would soon find ways to furnish goods at the old prices by competition.

XVI. Do the comparisons made by literal translation of British measures into metric, as made by Mr. Dale, etc., have any value as arguments? No; when a large number of cases are compared the advantage falls as much on one side as the other, at least when the proper figures are selected, adapted for each system.

XVII. Was the statement attributed to Professor Newcomb, that in common life the metric system has no advantage, correct? No; it was not correct. The columns of figures in our text-books of pounds per cubic foot would be abolished because useless. Our physicians and pharmacists would then use the same system as is used in common life, and would not have to learn and use a separate system; neither would all who want a good education.

XVIII. Do the manufacturers bear any proportion in number or interests to the school-teachers, professors, and students in the United States? No.

The above are some of the issues to which the subject could be reduced on which the evidence would be clearly on one side or the other, and would help greatly to settle the main question. Practically, in

my opinion, the metric system should be introduced into the post-office first, by a bill carrying a sufficient appropriation to change the scales, etc., which would not interfere with the machinists at all.

Sincerely, yours,

WM. H. SEAMAN.

[See Current Topics, Bureau of Education, No. 354.]

Pupils	18,589,991
Teachers	578,464
Total	19,168,455
Total expenses	$313,545,420
Twelfth Census, manufacturers and assistants	500,000

[Volume VII, second part, pages 1 3.]

Salaries	$403,711,233
Manufacturers ——per cent——	7
Population in schools ——do——	20

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THE DISCUSSION IN THE BRITISH PARLIAMENT ON THE METRIC BILL.

There lies before us a reprint from the Parliamentary Debates in the House of Lords on February 23, 1904. The order of the day was the second reading of the bill for the compulsory introduction of metric weights and measures into the United Kingdom of Great Britain and Ireland. We will make some extracts from the discussion which will show the present conditions over there and which will interest us because it is universally admitted that the adoption of the metric system by one branch of the English race will secure its adoption by the other. The reading was moved by Lords Belhaven and Stenton, but the principal advocate of the bill was Lord Kelvin. In order to show how great change had taken place in public opinion on the measure in recent years, as compared with the time not long ago when the chief argument of the opponents of the bill was that public opinion was not yet ripe for it, the noble lord presented petitions from 30 town and city councils, representing a population of over 8,000,000, from 50 chambers of commerce, 30 retail dealers' associations, 43 trades unions representative of 300,000 workers, 60 teachers' associations, inspectors of weights and measures in 80 districts, and a large number of individual signatures, bringing the total number of individuals represented to 333,000. A nearly equal number additional were promised within a week, the Liverpool Chamber of Commerce sending theirs separately by Lord Avebury, together with several chambers of agriculture. The difficulties alleged to be experienced by foreign countries in making the change were declared nonexistent. His Majesty's representatives abroad at the time stated the change was made without much difficulty; though some countries were more rapid than others, there never had been any desire to return to the old system, and the adoption of metric weights and measures had assisted the development of trade. Switzerland commenced to use the metric system eighteen months from the passing of the law. There was no great difficulty found there in the towns, but it was some time before it was adopted in remote country places. In Germany it was adopted more quickly than anywhere else. Two years and one month were allowed, and the interval thus granted was sufficient to insure the adoption of the new system in all details; it was an accomplished fact by the day named. There is no desire to go back to the old system, and the change has contributed to a rise of German trade and commerce, foreign trade deriving much benefit. There are some persons who object from a dislike to mental effort and who prefer to muddle on with the British system described by the prime minister as "arbitrary, perverse, and utterly irrational." To these I reply that the metric system is bound to be adopted sooner or later, and that personal inconvenience for a few days should not be allowed to interfere with a measure calculated to promote the trade and prosperity of the country.

We have had nine years of permission to use the metric system without thereby rendering ourselves liable to punishment for a breach of the law, and experience has proved that the change from the system that has been so long in use in this country to a new system can not be made over the whole country voluntarily. It is a case for compulsion, and I think the legislature will be thanked by the country for having applied compulsion. In Germany, France and Italy no inconvenience has resulted from the introduction of the metric system, and there has never been such a thing as a complaint. The change in Germany occupied only two years. I have in my hands a statement by Sir William Ramsay, in which he wrote, "I was in Germany during the change there; it gave no trouble whatever and was recognized within a week."

It is interesting to know that the decimal system, worked out by French philosophers, originated in England. In a letter dated November 14, 1783, James Watt laid down a plan which was in all respects the system adopted by the French philosophers seven years later, which the French Government suggested to the King of England as a system that might be adopted by international agreement. James Watt's objects were to secure uniformity and to establish a mode of division which should be convenient as long as decimal arithmetic lasted, a thing we may consider as absolutely settled.

I hope this bill will be sent forward with full pressure to the other House, 333 members of which have declared themselves in favor of it and ready to support it.

In introducing the bill, Lords Belhaven and Stenton recalled some of the testimony given in the Blue Book, known as the "Report on Weights and Measures," made to the House of Commons July 1, 1895. That report contained three recommendations, viz:

(*a*) That the metrical system of weights and measures be at once legalized for all purposes.

(*b*) That after a lapse of two years the metrical system be rendered compulsory by act of Parliament.

(*c*) That the metrical system of weights and measures be taught in all public elementary schools as a necessary and integral part of arithmetic, and that decimals be introduced at an earlier period of the school curriculum than is the case at present.

Of these recommendations the first was complied with by the permissive act of 1897, which made the use of the metric system in trade lawful (it was previously illegal to use it), and the third was adopted under the educational code of 1900. The second is in the bill now before us. An important point in the history of this subject is that in August, 1902, there was a colonial conference attended by all the premiers of the self-governing colonies, which passed this resolution: "It is advisable to adopt the metric system of weights and measures for use within the Empire, and the prime ministers urge the government represented at this conference to give consideration to the question of its early adoption." And since that time the colonies have been pushing the matter with great earnestness.

The saving of time in education by the use of the metric system is not only in the teaching of the tables, but the whole system of compound addition, subtraction, multiplication, and division, and the system of computation called "practice." Last year inquiries were made of head masters of schools on this subject, and 197 sent replies, of which 161 said the saving would be one year, 30 said it would be two years, and 6 said that it would be three years. The senior mathematical master of Edinburgh high school wrote: "An average scholar would save at least a year and a half, probably two. I conceive it to be not only a saving of time, but an economy of mental effort which is incalculable."

The commercial value of the metric system has been reiterated by British consuls in foreign countries for many years. In the Board of Trade Journal, February 15, 1900, the British consul at Amsterdam says: "The iron and steel manufacturers' unions of Germany have adopted a uniform system of dimensions based on metric weights and measures. The classifications are making more and more progress in Germany, not in the iron trades alone, but in other manufactures. In the future Germany, and the Continent generally, will have a constantly increasing advantage over British manufactures in foreign countries unless the metric system be fully and entirely adopted by Great Britain. I may mention as an undoubted fact that the preference which Germany has obtained here over Great Britain regarding railways, bridges, and other railway material is mainly owing to the existence of this metric classification."

Other items in the discussion were that Russia had directed her iron and steel works to alter their rolling machinery so as to produce only rods, rails, and sheets on a metric scale; that 45 per cent of British exports were to nonmetric countries and 55 to metric countries (66 per cent of United States imports are invoiced in metric measures). At present Britain has 80 different denominations, represented by 155 different kinds of weights and measures, which by this bill will be reducted to 30 denominations, represented by 53 different kinds of weights and measures, or only one-third the present number.

The bill was read a third time in the House of Lords May 17, and referred to a select committee to arrange the practical details necessary to carry it into effect. It was then passed and sent to the House of Commons and read the first time. This discussion showed that there was a very great popular demand in England for the introduction of the metric system, more than there is in this country at the present time. England is a small country, and the adjacent countries, France, Belgium, Holland, and all Scandinavia, use the metric system; hence people in general are brought much more in contact with it than in the United States, where we only touch the metric system directly in Mexico, and even this contact is having a decided effect in making the system familiar to our citizens.

The principal arguments now relied on by the opponents of the metric system here are that it has not displaced the old measures in countries where it has been legalized, and that its introduction would be a matter of enormous expense. Anyone who has had personal experience in foreign travel, or who will take pains to inquire of any of the thousands of immigrants that come among us, will soon convince himself that the metric system is the principal system in actual use in trade and commerce in European countries.

The very large number of working people who appear in Lord Kelvin's list as advocates of the metric system are drawn to its support not only by the actual contact with metric-using nations, but also by the handicap imposed by the British system on getting a useful practical education. This point is increasing in importance since the complete change of both British and American text-books to the metric system. The absurdity is patent of requiring the workman to use an old system different from that in which all knowledge is gathered by the original workers and communicated to their students, and of which the great mass of operatives are ignorant. The operatives themselves, as soon as they become fully aware of it, demand the possession of this key to knowledge and the higher education.

We have heard a great deal in the last three years about the enormous expense of adopting the metric system. The great majority of people who talk about this expense do not know anything about the actual use of the metric system, and have not brought one scrap of testimony that supports their views from countries that have made the change, while most of those who advocate the system are in the actual use of it as teachers, investigators, etc. The opponents of the system are in the position of a man who condemns a tool without ever having used it. Now Lord Kelvin said in his argument before the lords that "last year inquiries were made of head masters of schools, 197 sent replies, of whom 169 said the saving of time by teaching the metric system would be one year, 30 said it would be two years, and 6 said it would be three years. The senior mathematical master of Edinburgh high school wrote, that in view of the wearing out of teachers and scholars in obtaining a knowledge of the British system, the adoption of the metric system would result in not only a 'saving of time, but an economy of mental effort which is incalculable.'" Lord Kelvin's argument applies with even more force to the United States. The Committee on Coinage, Weights, and Measures say in their report, No. 1701, April 21, 1902, made to the first session of the Fifty-seventh Congress: "When we consider there are over 15,000,000 school children in the United States being educated at a public cost of not less than $200,000,000 per annum, the enormity of the waste will be appreciated. In the lifetime of a single generation nearly $1,000,000,000 and 40,000,000 school years are consumed in teaching a system that as a whole does not agree with any other nation in the world, and which does not offer any advantage whatever to compensate for its complexity." Surely the children and teachers of the country are worthy of quite as much consideration as the temporary personal and pecuniary interests of some manufacturers, who have failed to furnish, by either themselves or their representatives, any evidence whatever that the manufacturers

of Germany or Switzerland have or did suffer any loss whatever by the recent adoption of the metric system in those countries. No one in this country has proposed to affix any penalties legal or otherwise to the use of the customary system, what we do want, and are entitled to work for as citizens, is that the Government shall adopt in all its work the metric system, which is already the international system for a majority of the civilized world.

The American Machinist, of January 14, sums up the matter by saying what is true: "The testimony of men who have had experience in all parts of the world with both systems in the manufacture of machinery is practically unanimous, that most objections to the metric system are based upon purely imaginary difficulties, and that the testimony of men who have not had such experience does not amount to anything."

We are constantly asked what advantage will the metric system be to this or that particular business. The whole community is larger than any part of it, and is entitled to first consideration. We have shown above that one of the largest and most important activities in this country, the business of education, will be enormously benefited, and every other trade or business will also be benefited, by the increased effectiveness of mental effort in every direction which is the necessary consequence of substituting a simple and rational system for the complex, irregular and barbarous system now in vogue.

WILLIAM H. SEAMAN.

STATEMENT OF MR. WILLIAM HALLOCK.

Mr. HALLOCK. Mr. Chairman and gentlemen, I would like to respond in the first place to the last challenge.

The CHAIRMAN. I wish you would tell us who you are.

Mr. HALLOCK. I beg pardon for assuming that anybody knew me.

The CHAIRMAN. Some of us know you, but perhaps others do not.

Mr. HALLOCK. I am the head of the department of physics in Columbia University in New York, and dean of the science faculty there. Formerly I was in the Geological Survey in Washington, and the Smithsonian Institution.

The last speaker has emphasized most beautifully one of the strongest arguments that we have to make in reply to our critics, and that is, that they do not know the system that they are opposing. We are told that the electrical units are not metric units; that they are based upon the dyne, which he is not able to define, and he claims that he can not explain it to you. It is perfectly simple what a dyne is. A dyne is a unit of force based upon rational relations between the second as the unit of time and the centimeter as the unit of distance and the gram as the unit of mass. It has been recognized by everybody who had any knowledge of accurate metrology that we must adopt the kilogram, and it has been done by Congress in this country as a unit of mass and not as a unit of weight, because the weight of that mass is the force with which it is drawn toward the center of the earth.

Now, when it is said that "the gram is 981 dynes," that is not correct. The gram is drawn toward the earth with a force equal to 981 dynes, but it is not a force at all. It is a unit of mass. It is so much brass or so much platinum or so much gold or whatever it may be. The whole thing is befogged. The difference between horsepowers all comes in from the fact that the horsepower is the force that it takes to raise a certain mass 1 foot high in a minute, and it takes more force to raise a pound 1 foot high in certain places on the surface of the earth than it does at other places. There is where the confusion comes in, and that is where the confusion is in this case, and they are carrying over to the metric system that con-

fusion, and accusing the metric system of the confusion which is really due to their own system.

The dyne is derived from the unit of velocity in this way: The unit of velocity is a centimeter per second. Simple enough. The dyne is the force which will impart to 1 gram a velocity of 1 centimeter per second in one second's time. Now, if that is not metric, I do not know what metric is. The only nonmetric element in it is the second, and none of us have any desire to change that. The conditions are rather peculiar. I have so many things that I would like to say that I scarcely know what to say first.

I have recently finished a book on the history of metrology, and the present system particularly, and I should like in that connection, before we leave the electrical units, to point out that at the present time, not only in this country, but in England and the world over, the only units that are recognized as units for higher engineering propositions in the electrical profession are metric units. Everything is metric—the standards, the fundamental standards of length, and the fundamental standard of mass in this country and England are both metric. The only units that are not metric are the intermediate units between the standard and the electrical units. Where are our electrical friends? You do not hear any electrical engineers declaiming against the metric system, because they have got it and can not get rid of it. You buy your electricity—Congress pays for the electricity here in the Capitol—in metric units right along. So that we are between the upper and the lower millstone, and since this seems to be a place for prophecies and telling other people what they are going to do and how much it is going to cost, and so on, I would like to say that this situation appeals to me in just the opposite way from what it appeals to the last speaker. No doubt it is a fact that if the metric system in this country were to be decided, and could be decided in the next two months, it would go a great ways toward deciding the question for England. There is no doubt about that. But it is not going that way. It is going the other way, and it is a question, as I have usually expressed it, like a political campaign. You are going to be on the band wagon or under it, and I do not want America to be under it.

Now, with reference to this change, etc., again we have that horror of something we know nothing about. A gentleman appeared here this morning and stated that he did not know how he would be able to introduce that into his shop, and said, or intimated, that the only thing he could do would be to throw away everything and buy a brand-new set of tools right straight through. That sounds very well, and he might do it, because there is no telling what a man will do. But does he realize that if he introduces into the train of gears on the end of his lathe screw a cogwheel with 127 teeth on it he can cut metric threads as well as he could cut his inch threads? We bought recently from the Rivet-Lathe Company a lathe for $500 or $600, and they advertised for $5 to furnish the gears for the lead screw of that lathe which will enable it to cut a whole raft of metric threads. Now, I do not care to emphasize all of these points, or to weary you with long talking. I have been in the habit of talking for an hour, being a lecturer, but I will cut it short. You heard this morning, for example, that milling machines sent to France had the cutters specified for inch arbors. Why? Because they have to con-

tinue to order at present their cutters in this country, and they are now on inch-standard arbors. Most milling machines have on the three-motion screws micrometer attachments, enabling them to move the table in each of three directions and measure the distance. I do not believe those were put in in inches when they went to France to be used.

But here we have people saying: "Why do we want the two systems? Let us have our good old system." Bless my soul, we have got two systems, and we want to get rid of the poor one. All of the people when they talk about shipping things abroad have to consider the metric system. Brown & Sharpe manufacture metric scales and metric micrometers right along, and the condition there does not seem to interfere with them particularly. They manufacture them, and there is not very much difference in the price, on the average, between the one made on the inch and the one made on the millimeter.

Right there you have had a number of examples of the advantage of the inch as a standard of length over the millimeter. Now, right in those micrometers—which Brown & Sharpe make better than anybody else I know of; certainly better than anybody in the metric countries—that screw is approximately a quarter of an inch in diameter. What thread do they use there? They can not use a tenth of an inch; that is too steep. They can not use a hundredth of an inch; that is too flat. The result is that they use 40, so that a revolution of the head means one-fortieth of an inch. Then they subdivide that head into 25, so that the reading is in thousandths. Now, the man reads 17 on his head. What is that? He has got to stop and think, is that 17 plus one-fortieth, or plus two-fortieths or three-fortieths, or is it just 17? He has three things to remember.

Mr. LOVERING. Is that to get a pitch?

Mr. HALLOCK. That is to get the measurement. You screw up the micrometer and make a setting. In the millimeter the difficulty is simply halved, from the fact that if you make a half-millimeter thread, then you have 45, for example, and you only have to know that means 45 or 95. In the other case you have the choice of three mistakes that you can make.

I will not detain you longer than to point out this thing. We are asked as a constructive measure to adopt an inch as the unit of length, decimalize, and to go on from that. That gives you a foot which is not the present foot. It gives you a mile which is not the present mile.

Mr. LILLEY. How?

Mr. HALLOCK. What are you going to make the mile? The present mile is 5,280 feet.

Mr. LILLEY. Twelve inches to a foot.

Mr. HALLOCK. Yes, sir; that would be 63,360 inches. That is not decimal division of the mile.

The other proposition is to take 10 inches to replace the foot.

Mr. LILLEY. I have not heard that advocated.

Mr. HALLOCK. That is what Mr. Moores advocates. I read that article. They admit the decimal relation, and immediately violate it by taking the inch as the standard and 12 inches as one unit and 36 inches for something else. Then we have not the decimal system any more than we have had. Then the grain is the unit of weight in this country. That is the only unit of mass that we have now that is

standard, and we are told in the usual casual way that we will make the pound as near the usual number of grains as we can and yet maintain this relation between the unit of weight and the unit of mass, "if it is practicable." The other gentleman has not anything to offer. He has not even made up his mind whether our present system needs reform or not. Now, it is easy to sit still and say, "If you do not know what to do, sit still and do nothing;" but you do not get anywhere in that way. I would prefer to see the committee make a mistake rather than to see them sit down and say, "I don't know what to do; I am in a lot of trouble, and I don't know what to do." We have got to do something.

Mr. DUBRUL. How much will you pay for the mistake?

Mr. HALLOCK. I will pay all that falls to my share. The Government will pay for these changes. The Government, as far as it is concerned, will be the party that pays for the change in those tools.

Mr. LILLEY. He will add to the price?

Mr. HALLOCK. Yes, sir; he will add to the price, and they will tell you so.

STATEMENT OF MR. FRED W. TAYLOR, OF PHILADELPHIA, PA., PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Mr. TAYLOR. Mr. Chairman and gentlemen, I would like to appear, if I may be permitted to, first, as president of the American Society of Mechanical Engineers, and afterwards, if the committee care to hear me for a few minutes, as an engineer having no connection whatever with the American Society of Mechanical Engineers, not even as a member of the society, to say what I have to say as an individual.

The CHAIRMAN. Certainly; go ahead.

Mr. TAYLOR. Now, this is as president of the American Society of Mechanical Engineers. [Reads:]

GENTLEMEN: As president of the American Society of Mechanical Engineers, I wish to briefly state the position which this society occupies in relation to the compulsory adoption of the metric system.

In 1880 the American Society of Mechanical Engineers, after a paper had been read before it by Mr. Coleman Sellers calling attention to the disadvantages of the application of the metric system to ordinary machine-shop practice, passed the following resolutions:

Resolved, That this society approves and indorses the views expressed in the paper read by Coleman Sellers, esq., on the metric system of measurement, and deprecates any legislation tending to make its introduction obligatory into our industrial establishments; also

Resolved, That the secretary be instructed to communicate the sentiments of this resolution to anyone concerned in procuring this legislation.

In 1881 a referendum ballot of the society was taken, 80 per cent of the members voting in favor of the following resolution and 20 per cent against it:

Resolved, That the society deprecates any legislation tending to make obligatory the introduction of the metric system of measurement into our industrial establishments; also, that the secretary be instructed to communicate the sentiments of this resolution to anyone concerned in procuring such legislation; and further, that a copy of this resolution be sent to the Antimetric Society of Cleveland, Ohio.

In 1885, after a prolonged discussion, the society decided that from that time forward no standard should be officially adopted by the American Society of Mechanical Engineers, and since this date our society has never officially either adopted or condemned any standard or even any recommendation of its duly appointed committees.

In the years 1902 and 1903 there was a very extended discussion regarding the compulsory adoption of the metric system, and one of the results of this discussion was that the following resolution was adopted by the society:

Whereas the technical press in 1902 published statements implying that the American Society of Mechanical Engineers had taken action withdrawing its opposition to the adoption of the metric system as the standard of weights and measures for the United States; and

Whereas there is no foundation in fact for such statements: Therefore,

Resolved, That the society hereby records the fact that at no time has it taken any action reversing its original attitude of opposition to the adoption of the metric system or susceptible of such interpretation.

At about this time certain ballots were mailed to all the members of the society asking for an answer from each member to a number of questions regarding the compulsory adoption of the metric system. This ballot, however, merely expressed the individual views of those members of the society who saw fit to answer the questions propounded in the circular letter, and in no sense constituted either an indorsement or a condemnation by the society of the compulsory introduction of the metric system.

Only about one-fifth of the membership (or, to be exact, 514 members) of the society took the pains to answer these question; therefore even the personal opinions of those who answered can not be said to stand for the personal opinions of the full membership of the society. Of the answers received there were—

In favor of the adoption of the metric system of weights and measures as the only legal standard in the United States, 20 per cent, or 103 members.

Against the adoption of the metric system of weights and measures as the only legal standard in the United States, 80 per cent, or 363 members.

In favor of legislation which would promote the adoption of the metric system, 33 per cent, or 153 members.

Against legislation which would promote the adoption of the metric system, 66 per cent, or 311 members.

In December, 1903, the American Society of Mechanical Engineers adopted a new constitution, of which the following are two articles:

C 55. The society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings. Matters relating to politics or purely to trade shall not be discussed at a meeting of the society nor be included in the transactions.

C 56. The society shall not approve or adopt any standard or formula or approve any engineering or commercial enterprise. It shall not allow its imprint or name to be used in any commercial work or business.

Now, gentlemen, if I may be allowed to talk as an individual, not as president of the American Society of Mechanical Engineers, I would like to make a statement.

The CHAIRMAN. We would be glad to hear you.

Mr. TAYLOR. If I can talk about five minutes without interruption I shall then be glad to answer all questions that may be put.

I want to qualify, first. I left college and served two apprenticeships; one as a pattern maker and the other as a machinist; and after that, in 1878, I entered the employ of the Midvale Steel Works in Philadelphia, as a laborer, because I could not get any other work at the time in a higher capacity. I worked there first as a laborer—in the machine shop—and then as machinist, then as gang boss, next as assistant foreman, then as foreman, master mechanic, chief draftsman, and chief engineer of the works, and remained as chief engineer from 1884 to 1889, when I left the works. During this time I had charge of rebuilding and reequipping the establishment, so as to put it in shape for making the forgings and other parts of the large cannon which are now used in our Army and Navy.

The first gun was made there while I was chief engineer—the first modern high-power cannon for the United States Government. In designing the machinery for making these forgings, boring and machining and tempering them, I of course had a great many draftsman and mechanics under my supervision.

I afterwards spent nine months in reorganizing the Cramp Shipbuilding Company's plant, and for three years, from 1898 to 1901, I was engaged in reorganizing the Bethlehem Steel Company in Pennsylvania. Those are the three largest works in the United States which do Government work.

Now, as I said, I make the above statement in order that my views will have whatever weight they should have as an engineer.

I use the metric system of weights and measures myself in many of my calculations, and I want to call your attention to the first paper that I wrote for the American Society of Mechanical Engineers. It was a scientific paper; at least it seems to me proper to call it so. It was an analysis of the relative value of the various gases—such as Siemens gas, water gas, natural gas—that were then in common use in the large steel works of the country for metallurgical purposes. In making my calculations and in writing this paper, as any other engineer would probably have done at the time, I used the metric system exclusively, because it was so much simpler to use it than it would have been to use the old-fashioned system, and I was surprised when I presented this paper to the society to have it refused. They sent it back to me and said that no paper could be presented to that society without at least in all cases giving the equivalents in the English measurements. They said they would accept no foreign standards of measure alone—Chinese, French, nor any other.

Mr. WOOD. When was that?

Mr. TAYLOR. In 1886.

The CHAIRMAN. Twenty years ago?

Mr. TAYLOR. Yes. That rather angered me. However, I rewrote the paper and presented it in its present form, giving both American and metric units of measure.

This pointedly called my attention to the issue and I became a strong advocate or proponent of the introduction of the metric system, because I used it myself in a certain class of calculations and I believed it was the proper thing to introduce as the standard in the

United States. However, after giving careful thought to the practical effect of its introduction upon our industries, and particularly upon our workingmen, it took me three days to become one of the strongest opponents to the compulsory introduction of the metric system in this country. Let there be voluntary introduction, but not compulsory introduction. In three days' thinking, I say, I changed right over from being an advocate of the introduction of the metric system and became a strong opponent of its compulsory introduction.

The CHAIRMAN. Compulsory introduction?

Mr. TAYLOR. Yes; by the Government or anywhere under the sun. I say let every man have it if he wants it, but let no set of men be forced to use it merely because a lot of scientific men, who have not studied its working in our shops, wish to arbitrarily force it upon us.

I will tell you why. It is not on scientific grounds at all. I use it myself. But for every time that I use it once, or any scientific man uses it once, every machinist in the United States bumps up against it a hundred times a day and all day long. The inch, half inch, quarter inch, five-eighths, thirteen-sixteenths, three-fourths, and seven-eighths are the machinists' property, their asset. They belong to the machinist, and for his use they are vastly more convenient and simpler than the metric millimeter ever could be, even if the inch were wiped out of existence.

I was utterly astounded when I came out of college and started to serve my apprenticeship to see my boss pattern maker and other pattern makers go up to a lathe and put a rough piece of wood into the lathe, and, without any measure other than their eye, turn that piece of wood to any size which they wished, from 2 inches down, and finish it just as accurately as if they had used gauges. I want to tell you this three-quarters of an inch is something to them. It is an absolute fact to them, and the half inch is one of the important facts of their lives. They live with it. It is a language to them. They talk and think more in inches than in words while at work, and they are doing that all their lives long. When I was told that they could learn to adapt themselves to any standard, I believed at first that this was the truth, but the more I studied the matter the more I became convinced that the metric system never could by any possibility be made anything like as convenient or desirable for our workmen as the inch is. And what I wish particularly to emphasize is that the workmen use our system of linear measures far more than our scientists and college professors do, and that the use they are forced to make of it is radically different from that of the scientist, and that there are 10,000 workmen in the country who would be injured by the compulsory introduction of the metric system to each college professor or scientist who would be benefited by it. And, gentlemen, these workmen have not appeared before your committee and stated their side, and that is what I am trying to do for them. In trying to do this there are certain facts to which I wish to call your attention.

First. It is an absolute fact, not a theory, that in the workshops of Europe the millimeter is the standard of measure universally used, not the decimeter, centimeter, or the meter. In the shops of this country the inch is the standard of measure, not the foot, or the yard.

Second. The inch is a vastly more convenient unit of measure for the workman, because its size is much closer to the average of things

which the workman has to make than the millimeter is—the inch being about the size of the implements conveniently grasped by the human hand, while there are 25.4 millimeters in 1 inch, or, it takes 10 millimeters to measure the width of the nail on the little finger of a man's hand. The inconvenience of this small unit will be shown later.

Third. The use which the workman has to make of the linear standard of measure is directly the opposite of the use which the scientist or professor makes, and the real essence of the conflict in the interests of the two lies here.

Fourth and worst of all. That if the Littauer bill becomes a law the real metric system will practically not be used, but a fake metric system will be forced upon our Government Departments and upon those having dealings with them. Our ships, and practically everything inside of them, and our cannon and ordnance will continue to be designed and built in inches, because it is physically impossible for most of our machines to produce anything but inches; but these inches will have their name changed and take on the fake name of millimeters—that is, instead of saying 1 inch our Government drawings will say 25.4 millimeters, and instead of saying three-fourths inch they will say 19.05 millimeters, but our workmen must continue to use the inch all the same. This is a fake, not a genuine use of the metric system and a great hardship for our workmen.

Fifth. If ever this fake is forced upon our workmen, I predict that it will make such a storm of opposition as will sweep those who have been instrumental in compelling them to use it out of political existence. [Laughter.]

The third statement which I made above requires a little further explanation, namely:

> Third. The use which the workman has to make of the linear standard of measure is directly the opposite of the use which the scientist or professor makes, and the real essence of the conflict in the interests of the scientist and the workman lies there.

When a man making a scientific investigation is called upon to measure a given object, to him it is a matter of comparatively little importance whether he uses a scale with inches or one with millimeters, because the actual measuring can be done about as readily with one scale as with the other. The scientist, however, writes down on a piece of paper which is at hand each measure as soon as he makes it, and after all of his measures have been taken down he usually proceeds to make a calculation or computation of some sort, using the dimensions of the object in question in his figuring. Now, for much of this class of figuring the metric system has distinct advantages over the inch system, and, this being the case, the scientific man naturally prefers the metric system, and sees, in nine cases out of ten, no reason why the mechanic should not also use it.

The mechanic, on the other hand, instead of having an object given to him which he has to measure, has a drawing given to him, showing a part of a machine which he has to make; and upon this drawing are written many dimensions. It is the business of the mechanic to go to this drawing, which is kept close by his machine, but not right where he is working, because it would become covered with dirt and illegible if it were kept right at the work; therefore the mechanic must walk a step or two, at least, from his work, and read from the

drawing the one, two, three, or four dimensions which it is necessary for him to have in order to make the part of the machine which he is working on. And these dimensions he must in almost all cases carry in his head, remembering them while he is either setting the various calipers, gauges, etc., or, in many cases, throughout the whole time that he is engaged in shaping the piece. The mechanic, then, must carry a lot of measures in his head, while the scientific man is able at once to put them down on paper. The mechanic can not, in most cases, put the dimensions on paper, because his hands are necessarily greasy with handling his machine and also because his hands are busy while he is doing the work. From this it follows that, contrary to the scientific man, it is of the greatest importance that the unit of measure which the mechanic is called upon to remember shall be the one which is easiest for him to carry in his mind.

As I have said above, there are very few objects which the mechanic has to make which are as small as a millimeter, whereas the vast majority of the parts which the mechanic has to make, say, on a lathe, will run between one-half an inch and 6 inches in diameter. Now, it is a very easy thing for a mechanic to read off of a drawing and then remember that the piece which he is going to make is, say, 4¼ inches diameter and 7 inches long. It, however, would be a distinctly difficult task for the mechanic to remember these same dimensions providing they were expressed in metric units instead of inches, namely, 107.95 millimeters in diameter and 177.8 millimeters long. This illustrates the fundamental fact that the metric unit (the millimeter) is entirely too small for convenient use by the mechanic, and while at first sight this may appear to be a comparatively unimportant objection, in fact it is a matter of enormous consequence to the workman. Illustrations of the inconvenience to which this minute unit of measure puts the mechanic might be multiplied indefinitely. I will, however, give one more. Time and again it is necessary for the mechanic when he reads the dimensions from his drawing to add up a series of dimensions. For instance, he must read off and add up in his mind, without putting them down on paper, say, 5½ inches plus one-half inch plus three-eighths inch. It is very evident that any mechanic with ease would add in his mind the above figures and say at once 6⅜ inches. The corresponding metric measurements would be 127 millimeters plus 12.7 plus 9.525. Now, I will defy any ordinary mechanic to add up these figures in his mind without putting them down on paper. And remember, gentlemen, that if the mechanic is forced to take a piece of paper and perform the sum in addition it counts more for him than the mere inconvenience—he loses money by not being able to turn out his work so fast. I would again call your attention to the fact that this trouble is brought about by the fact that the millimeter is entirely too small for a convenient unit of measure.

Now, if any of you gentlemen wish to convince yourselves whether or not the millimeter is the real unit of measure in the foreign system, and that the inch is the unit of measure in the shops of this country, just take the trouble to get the drawings of some of their machine parts of about the dimensions that I have mentioned, and also take the trouble to get the drawings of some of the similar parts

made, say, in our Government department which designs our ships and engines, and you can satisfy yourselves on this point.

Referring now to the fourth fact stated by me above, namely, that if the Littauer bill becomes a law the real metric system will practically not be used, but a " fake " metric system will be forced upon our Departments and upon those having dealings with them. I will try to make myself clear on this point.

I designed many of the lathes and other machines that are now in use in the Midvale Steel Works, and am thoroughly familiar, through three years' experience, with the machines used in the Bethlehem Steel Company for making Government guns, gun forgings, projectiles, etc., and also with the machines used at the Cramp Shipbuilding Works, in Philadelphia, in making large armor clads, and I can assure you that the inch is absolutely a part of every one of those machines. All of their dimensions are in inches or fractions of an inch. All of the gearing and lead screws and the longitudinal and cross feeds of these lathes are made to work to inches to cut screws, etc., of the United States standard. Now, some of these enormous lathes and other tools took as long as four years to design and build, and, all together, they cost millions of dollars. They embody the inch and they are made to work in inches, and it is out of the question to cut a real metric screw thread in these lathes.

What the Government Departments will do if the Littauer bill forces them to use the metric system will be that they will design their guns and ships in inches, just as they have heretofore, and that they will then translate these dimensions, which are really inches, and give them the vastly more complicated metric names. The real dimensions will remain inches and fractions of an inch, just as heretofore, but they will have the new metric names; and what is this but a fake metric system? And, gentlemen, what is the workman going to say and to think when this monstrosity is forced upon him fifty times a day? There would be little or no trouble for the designers in the Ordnance Department of the Army and Navy, or even in the shipbuilding department, to write on their drawings these new metric names for the old inches; but for the workman who has to first read these new names which are given to his old friends and try to carry them in his head, and then translate them into inches, and then proceed to adjust his gears so as to cut a given thread that is called for, you can readily see that it is not only no improvement over the old system, but from his viewpoint it is nothing but an infernal fake.

Do not misunderstand me on this point. It may be possible to design a good many of the dimensions of guns, parts of ships, etc., in real metrical measures, and the workman would then merely have the inconvenience and difficulty of using the small metrical unit (the millimeter) instead of the more convenient unit, the inch. But it is out of the question and utterly impossible for our Government Departments to design all the parts of a gun or of a ship in real metrical units; therefore, in order to have anything like consistency, to avoid endless confusion, the easiest way out of the difficulty for the Departments would be, as I said before, to use the inch in their designs, and then change not the dimensions, but merely the names to the metric system.

There are about 5,000 workmen in the Bethlehem Steel Works and about the same number, I think, in the Midvale Steel Works. I know

these men well; many of them are my personal friends, and I have worked with them. They are, on the whole, remarkably intelligent men and wish to be up-to-date, and I feel quite sure that if you were to pick them out at random and ask these men to-morrow, "What do you think about the metric system?" many of them, perhaps even five out of six, would say, as I said in 1886, "Certainly I know about the metric system; I studied it in school, and I think it would be a very good thing." These men are desirous of being up-to-date, but very few of them have any practical notion of what the metric system consists. But if they once started to use it, then they would immediately find that they had to set the gears of their lathes so as to cut metric screw threads.

The CHAIRMAN. You were talking about lathes?

Mr. TAYLOR. Yes; I am speaking of any kind of machine that cuts screw threads, of all types of machines that do work of that character. These machines, as I said before, are designed and built in inches. Now, when you show a workman a drawing that has perhaps 50 different dimensions on it and then oblige him to use the metric names for inches [Mr. Taylor here held up for the committee a sheet of paper having the metric equivalents for the inch and fractions of an inch written upon it] it is right here the workman will be made to suffer.

The CHAIRMAN. What is the tool that he actually uses in getting these measures? I mean the workman. What tool does he actually use in duplicating these measures?

Mr. TAYLOR. The tool which he actually uses is the lathe which is fitted up with feeding gears and leading screws, which are adapted to cut threads designed according to the United States standard in inches, not in millimeters, and the workman in order to transfer the dimensions from the drawing to the work must use this [pointing to same table of metric equivalents which he had before held up], and then he must find out what gears he must adjust in the machine in order to cut the screw threads which are wanted.

The CHAIRMAN. He wants to produce the screw thread that is produced by that lathe?

Mr. TAYLOR. Yes.

The CHAIRMAN. Now, you say, supposing there is a translation, he could not produce any other thread by using that lathe, could he?

Mr. TAYLOR. No; the lathe will only produce screw threads of the United States standard—namely, in inches.

The CHAIRMAN. So that all he would have to do to comply with the Government order, providing the Government did the translating, would be to use that same machine? He could not make another thread?

Mr. TAYLOR. Yes; the workman would use that same lathe, not, however, to make millimeters, but to make inches, just as he has always made in the past. The machine will not make anything but inches, and all that has been done in the Government Departments where the drawing has been made, under the Littauer law, has been to change the name of the inch, say, to 25.4 millimeters, or, say, of the three-eighths of an inch to 9.525 millimeters, and that is just where it hits the workman hard.

The CHAIRMAN. Let us see how the workman is hit. The Govern-

ment wants to duplicate an order of that machine. Say the Government officer does the translating.

Mr. TAYLOR. As I have said, I am intimately acquainted at those works. There are 10 Government officers stationed there, and 5,000 workmen not under the employ of the Government. The Government officer is not of the slightest assistance to these workmen in translating measurements for them. He never comes near them until the work is done, and then he examines the work, and says either that it is all right or that it is wrong.

The CHAIRMAN. I do not think that you understand me. If the Government wanted that work duplicated they would use the same machine and measurements. The measurements can be expressed with sufficient accuracy under either system?

Mr. TAYLOR. Certainly, but the inch system is simple and easy for the workmen to work to, while the millimeter system is more difficult, and the fake millimeter system, which is contemplated by the Littauer bill, is intolerable.

The CHAIRMAN. If the Government wanted to duplicate that machine, it would make no difference whether they do the translating in the Government Departments or in the shops. Where would the expense or cost or trouble or considerable annoyance come in?

Mr. TAYLOR. I have mentioned the word "expense," gentlemen; that is another matter, and it is all there. I am trying to tell you what the workmen of this country would say about it when you asked them to abandon the simple names by which they have always called their old friends, the inch and the fractions thereof, and take up instead 25.4 millimeters. That is the real disgusting thing that the Littauer bill causes the workmen to butt up against. There are 5,000 of those workmen in this country to every engineer, and there are 30,000 of them to every scientific man; and in giving the few scientific men and professors what they ask for, gentlemen, remember the workingmen who are really the sufferers.

The CHAIRMAN. I would like to ask you a question.

Mr. TAYLOR. Won't you allow me to get through first? I will not take a very long time.

The CHAIRMAN. Yes; go on.

Mr. TAYLOR. Now, the workmen are in some respects as prejudiced and about as hard to budge as any set of men that you will find anywhere. I was in those shops when the Government started to use decimals of an inch, and if it had not been for the fact that every workman in the place knew what a quarter of a dollar meant and knew that it meant 25 cents, and knew what a half dollar meant and that it meant 50 cents, and that three-quarters of a dollar meant 75 cents, by Jove! without that you would have had a very difficult time to have gotten them to use decimals of an inch. The introduction of the decimal of an inch was made easy only owing to that fact.

Mr. WOOD. That is, only decimals of an inch?

Mr. TAYLOR. Yes. It was decimals of an inch that the Government adopted on their drawings, and which we were obliged to introduce in the shops. Now, to take another illustration, gentlemen, which from its simplicity may be more clear to you than that of a lathe or other machine-shop tool, suppose you were to pass legislation compelling the use of the metric system upon our railroads. Let us assume that you could force the adoption of the metric system

upon the railroads throughout our country. The standard gauge of our railroad tracks—that is, the distance from one track to another—is 4 feet 8½ inches. You could legislate and force the metric system upon the railroads of this country from now till doomsday and the tracks would still remain 4 feet 8½ inches apart, because in order to make a change in the width of these tracks to really conform to the metric system, it would cost in this country not less than a thousand million dollars. You could change the name of these 4 feet 8½ inches and give it a metric name as follows: 1.4351 meters, but that would no more alter the width of the tracks than the passing of the Littauer bill will change the use of inches on our lathes into millimeters. The lathes will still remain in inches, just as the railroad tracks would, although the names of both will be changed. Talk about changing the gauge of the tracks—the distance between the rails gradually—it would all have to be done at once. What would really happen would be that the tracks would stay just as they are, but every railroad hand would have to stop calling it 4 feet 8½ inches and give it a new name, which to him is meaningless, worse than meaningless. You can not legislate the inch and the foot out of existence in this country. It is an utter impossibility.

The CHAIRMAN. There would be no trouble in measuring a railroad track with sufficient accuracy in metric units?

Mr. TAYLOR. No; but please let me get through first. Let me try to bring this change home to you, gentlemen, personally. I am a mechanic, and therefore a fake change from the name of the inch to that of a millimeter hits me hard. Probably none of you gentlemen are mechanics, and therefore the change contemplated by the Littauer bill would not trouble you in the least. You know, however, that there is a strong movement in the world to introduce a universal language—the Volapuk language—as strong a movement, nearly, as yours is to introduce the metric system. [Laughter.] Suppose that Congress were to enact legislation to the effect that every Government employee were to be required to use the Volapuk language on and after such and such a date, and you gentlemen were asked to call this thing a chaise [pointing to a chair] and not a chair. Suppose that you were made to call that thing [pointing to a window] not a window but a fenetre. How would that strike you? Now, this changing the name of the inch and the fractions thereof to the fake name of millimeters hits the workman harder than the change to the Volapuk language would hit you, because you would not lose much time over it, for you would simply ignore it, while the workingman would be absolutely obliged to be bothered with his change from morning till night.

I do not believe that these gentlemen at all appreciate the part that inches and their fractions play in the life of the mechanic. When I came to offer myself as an apprentice, having just come out of college, the first question asked me by the superintendent was, "Do you know the rule?" "What rule?" "Do you know the rule?" he said. I said, "I do not know what you mean." He said, "Hell! Do you mean to come here and ask to be an apprentice and do not know the foot rule?" I said, "I know a foot rule." He laid a foot rule down on the table before me without any figures written on it whatever, and placed the point of his knife on one of the lines and said, "Tell me quick what that means." Of course

I was entirely unable to do so, although if I had had time enough I could undoubtedly have told him that it was $5\frac{3}{16}$ inches. He, however, found out what he wanted to know, that from his standpoint and the standpoint of any good mechanic I knew practically nothing about the rule. I tell you this, gentlemen, so that you may better appreciate the great part that the inch plays in the life of the mechanic, and that you may understand what you are up against when the Littauer bill legislates a new and perfectly preposterous set of fake names for the inch, the good old friend of the mechanic. Then, gentlemen, remember that these mechanics are also the voters in this country, and I tell you just as sure as you are born that those gentlemen who are instrumental in forcing this monstrosity upon them will be wiped out of political existence. [Laughter.]

The CHAIRMAN. Now, I want to see what the workingman is up against. You want to duplicate a machine, say, and you put into the hands of the workmen a lathe that can produce only one part and could not produce anything else with it that he wanted to, and you say simply because you call what he produces it with a different name he is going to be horrified?

Mr. TAYLOR. No; he will not be horrified merely because of a change of name, but because owing to the fact that he must first read the dimensions of his drawings in millimeters, then hunt up a large table of metrical equivalents and there find his real dimension in inches. Owing to this tomfoolery the workman's time is wasted; he can not work so fast and is unable to earn his proper piecework price. In the course of the day, he has say, forty to a hundred dimensions, each one of which he must study and translate from this to that [Mr. Taylor here holds up a table of inches and their fractions with metrical equivalents opposite to them].

The CHAIRMAN. But this machine must turn out the product nevertheless?

Mr. TAYLOR. I do not think that you understand what a lathe is. A lathe is not like a loom, which, after it is set, can only weave the one particular pattern which it is set for. A lathe is run from morning till night by an intelligent man who is obliged to guide it, as it were, just as if it were a high-spirited horse. The workman is obliged to add his personal skill continually to that of the lathe in order to turn out accurate work. The lathe by itself would do nothing but spoil the work, and no intelligent workman would allow it to run for ten seconds while he was away from it. The lathe hand is an intelligent man who is paid $18 or $20 per week. He has to have a lot of brains to use his machine, and that is what he is paid for.

Mr. WOOD. Then it is not simply a mechanical matter?

Mr. TAYLOR. You are quite right. It is by no means a simple mechanical matter. In the works of the Bethlehem Steel Company, the Midvale Steel Company, and the Cramps Shipbuilding Company the work which is done for the Government is of such a character that it requires highly skilled workmen in order to bring out any work whatever from the machines. While the metal is actually cut in the machines, it is, in fact, the workman who turns out either the good or the bad product, and without the continued personal skill and attention of the workman the machines in these places would do nothing; and in these works the workmen practically never use the

standard gauge. They work continually to dimensions, which they are obliged to read off of the Government drawings, and they then set their calipers or gauges and themselves have to measure up each dimension on the work as it proceeds. To illustrate the difference between these establishments which work for the Government and other establishments which turn out work which is duplicated over and over and over again: For example, the Baldwin Locomotive Works, in Philadelphia, employ about 15,000 men in building a locomotive, and in their case the work is so subdivided that in a considerable part of the work of building a locomotive one workman will spend years in making over and over again the same part, as, for instance, in doing a particular kind of work on one of the brass boxes which goes into a connecting rod of a locomotive. On this particular kind of work the real metric system (not the fake metric system which the Littauer bill would force upon our Government Departments) could be introduced without any serious hardship coming to the workman, because in this case the workman does not himself take the measures off the drawing, carry them in his head, and then shape the piece according to those measures. On the contrary, a definite solid gauge is handed to him or sent to him from the tool room, and he does not have to bother at all in reading a drawing. He merely cuts down the part of the brass box on which he is working until this solid gauge which is sent him fits over it; so that you see it is of very little consequence to him whether the measures are in the English or metric system.

Now I want to call your attention to the fact that the Baldwin Locomotive Works are able to work in this manner because they have such an enormous volume of business all exactly of the same kind, and since they employ 15,000 men it is evident that they are able to subdivide the work into very small sections, each of which becomes, when in this way subdivided, very simple and permits of the economical use of solid gauges as above referred to. On the other hand, the work of the Midvale Steel Works, Bethlehem Steel Works, and the Cramps shipyard, who are the three largest Government contractors. can not be in this way subdivided, so that the introduction of the metric system in their works (and far more the introduction of the fake metric system) would be to them a terrible hardship. Now, gentlemen, there are very few works in this country like the Baldwin Locomotive Works who can subdivide their work to that extent. The real manufacture of machinery in our country is done by comparatively small companies, scattered here and there throughout our small towns and cities, and the work done in these works is similar in character rather to the Cramps shipyard than to that of the Baldwin Locomotive Worke—that is, as far as the use of the metric system is concerned.

The CHAIRMAN. We will admit that at the beginning it would be difficult, as you say, to work to a size indicated by a metrical expression; but supposing, in the special case you mentioned at Baldwin's, you would not only give that workman the metric size, but its equivalent, and that would be done by men who are skilled in translation. Do you see under such circumstances what inconvenience your workmen would have or would find in using that machine, when it could only run in a certain way, and could only run and do the operations

and the work that it is intended to do? What is your workingman up against in that event?

Mr. TAYLOR. You have not stated exactly what the lathes and machines which I have been speaking about are capable of doing. They can do any piece of work under the sun in inches, but they can not cut screw threads and similar work outside of inches. They can make any gun that the Government designs in inches, but there is much of the work on a gun which these machines could not do if the guns were designed according to the real metric system.

The CHAIRMAN. Suppose you wanted to duplicate work that they had been doing every day?

Mr. TAYLOR. The Midvale Steel Works, the Bethlehem Steel Works, and the Cramps Shipyard do very little work which is the exact duplicate of what they have done before. I know of many of the machines in these works in which the same job will hardly be repeated once a year; then again, as the Government departments improve their designs of ships and cannon, they change their drawings from year to year. I do not think you have any idea how complicated most of these gun and ship drawings are. Gentlemen, just get one of those Government drawings or shop drawings and see the elaborate measurements which are written on them. Many of them will have a thousand measurements upon them. Now, if these dimensions are written in the fake metric system, which they will have to be under the Littauer bill, it will be out of the question for any shop to employ, as you have suggested, a man to be alongside of every workman and translate the metric measures into inches. Each workman will have to do that for himself, and in doing it he will have to use a book similar to this one which I hold in my hands, about 12 inches long and 9 inches wide, which has been prepared by the United States Government so as to help workmen in translating from the metric system to the English measures. Now, this book has 38 pages, and the workman will have to first look at the dimension on his drawing, then turn over page after page in this book until he finds the one on which the equivalent to this measurement is given in inches, and only then can he start to do the work on his machine; and remember, gentlemen, this must be repeated, say, from fifty to one hundred times a day by the workman. His hands are necessarily greasy and dirty, and what condition do you suppose this book will get in after about ten days' use?

The CHAIRMAN. What trouble would he have if the figures were followed by another set of figures in fractions?

Mr. TAYLOR. If every Government drawing had written upon it, first, the dimension in inches and then the same name for that measure in metrical figures—that is, millimeters—the first thing that a sensible workman would do would be to stop working on his machine and go over the drawing from top to bottom and scratch out every one of the metric figures so that they need not confuse him and cause him to make a mistake, then he would use in shaping the piece the dimensions which are given in feet and inches.

Mr. WOOD. That is, he would still use the United States standard?

Mr. TAYLOR. Yes. You can legislate till doomsday, but the workmen will not use those fake metric measures. If you want to get at real facts as to the effect of the metric system on the workmen of

the three works, for example, which I have spoken to you about, why do you not call any one of the superintendents of these works—I mean the men who handle the workmen in these works—before you and examine them? If you think I am not competent to speak for the workmen, go to them. I believe I am competent, however, as I have worked myself as a workman in those works and have spent between fourteen and fifteen years, all told, in the three works, and, as I before said, I was engaged through a great part of the time in reorganizing these plants. I have also had a good deal to do with the machines which are now in use in the Washington Navy-Yard, as I was called upon to assist in designing them to a certain extent at the time they were being made.

Mr. WOOD. You think this difficulty which the manufacturer suggests is not chimerical, but that there is a solid basis for it?

Mr. TAYLOR. Gentlemen, you just let the manufacturers in this country have the faintest notion that this bill is going to be favorably reported and likely to pass and you will hear from them. [Laughter.] I did not believe that there was the slightest danger of this bill being reported, and I do not believe there is now. [Laughter.]

Mr. BOWERSOCK. Let me ask you a question now, Mr. Taylor, please, for the purpose of getting a little information that I can understand. When you came into the shop they asked you if you knew the rule. It seems that you did not know the rule.

Mr. TAYLOR. Not in the intimate manner in which a workman is called upon to know his rule. In that sense I did not know it. I was a college man, however, so that I was acquainted with the foot rule, as any man of intelligence is.

Mr. BOWERSOCK. Suppose it had been a metric rule, and it had been explained to you and you had understood, as I believe you were competent to understand it, and if that metric rule had become a part of your property, and you had gone on and operated under it, could you not have used it with the same facility that you use the inch rule now?

Mr. TAYLOR. You ask me whether I think that the metric rule for an ordinary machinist would be as easy or simple a rule to work with in his shop as the inch rule, providing he was brought up to that?

Mr. BOWERSOCK. No. You went into the shop, a college graduate, and did not understand the rule according to your foreman, and he explained it to you. I say, suppose that was a metric rule and he explained it to you, then it would have been a part of your property, and you could operate upon it as you now operate under the inch rule with the same facility. If not, why not?

Mr. TAYLOR. I will tell you why not. As I have said before, the millimeter, which is the standard of measure throughout the metric countries (not the centimeter or the decimeter or the meter), the millimeter is entirely too small a unit for convenience. The workman who goes to the drawing can easily remember, say, $6\frac{1}{2}$ inches, and carry this figure in his head for a long time while he is turning a piece down in his lathe or planing up a piece of wood, etc., but if this same sized piece were called 165.1 millimeters, it would be very much more difficult for the workman to carry this in his head while he was working on it than it would to carry $6\frac{1}{2}$ inches. In other

words, the inch, fortunately for the mechanic, represents a unit of measure which is fairly close to the average size piece which the workman is called upon to make, and this is the real foundation for the greater convenience of the inch system over that of the millimeter system. Perhaps I could make it more clear to you, gentlemen, if I were to ask you to speak of a dollar, not as a dollar, but as a thousand mills; or suppose, instead of saying 78 cents you had to always think of 780 mills. Surely it would be vastly easier to speak and think of it as a dollar than as a thousand mills. I think I am right in saying a thousand mills is a dollar. I do not quite know. [Laughter.]

Mr. DRESSER. I will stand for that. [Laughter.]

Mr. TAYLOR. Now, suppose every time you talked about a dollar you had to talk about a thousand mills instead. The mill is entirely too small a unit to be convenient. In the same way the millimeter is entirely too small a unit. It is inconvenient to handle. The inch is the most handy unit for the workman to work with. As a scientist I like the millimeter, because for multiplying and dividing and for intricate calculations, etc., it is handier and works in with the system of weights and measures better for a man who is making calculations; but the workman has to make no such calculations. On the other hand, he does have to carry in his mind these units of measure and remember them all day long while he is working with them, and the units which are most convenient to carry in the mind, namely, the inch, are not necessarily the most convenient to work with in scientific problems. When I wrote this paper, I wrote it in the metric units, and I show you this so as to convince you that I am not in the least prejudiced in the matter, and that, on the contrary, as a scientific man I use the metric system.

The CHAIRMAN. Is it not a fact that almost the universal testimony of men who are equally familiar with both systems, who think in both systems, and in one as easily as in the other, is it not a fact that their testimony is that so far as the application of weights and measures is concerned to practical use there is no difference in the systems?

Mr. TAYLOR. No, sir; it is just the opposite to what you say. You will find that all men who have investigated the matter carefully and have come into actual contact with the practical use of the two systems, that their testimony will be universally against the metric system in practical work. For calculations and for theoretical work you will find that the testimony will be in many cases in favor of the metric system. As to this fact you will find plenty of evidence in the proceedings of the engineering societies. I do not want to drag that in, however, because it may be said, if I do so, that I am representing the American Society of Mechanical Engineers. In fact, I want to withdraw all reference that I have made to the American Society of Mechanical Engineers, because I am the president of that society. I do not wish to have it said for one instant that I am representing that society here. [Laughter.]

The CHAIRMAN. I say engineers, because so many of them have testified before the committee.

Mr. TAYLOR. I have not looked over the names of those engineers, but I fancy that they are men, many of them, who have not bucked up into close personal contact with the American workman. It is not

the engineers who would so seriously object to the introduction of the metric system, although unquestionably four-fifths of them would be opposed to it. They, however, could stomach anything. [Laughter.] It is the workmen who will be the hardest hit, and they will not swallow it.

The CHAIRMAN. Let me ask you a question or two. You have mentioned a special case. Now, referring to this bill, supposing the Government of the United States wanted to buy an engine or a gun or a lock or a mowing machine or a sewing machine or any article manufactured as a standard article; it would order it, would it not, in the usual way, the same as anybody else would order it?

Mr. TAYLOR. No, sir. The Departments of the United States Government are obliged by law to advertise for competition on all purchases which they make, and it is for this reason that they order only upon definite, clear-cut specifications. In asking for bids on a machine they specify distinctly the dimensions of the machine and state the exact work which it must be guaranteed to do, and in their specifications—I have read thousands and thousands of them—it is necessary for them to use dimensions in describing, say, a machine, or whatever the article may be that they are purchasing.

Mr. WOOD. As a matter of fact, they do use measurements?

Mr. TAYLOR. Yes. Get their advertisements, gentlemen, and see for yourselves. Get the proposals which they send out asking for bids.

The CHAIRMAN. If they wanted a mowing machine would they specify the size of the crank shaft?

Mr. TAYLOR. Yes. If they wished to buy a mowing machine they would advertise for bids on a mowing machine capable of cutting a swath of grass or grain so many inches wide, and they would also state the maximum weight allowable for such a mowing machine and many other items describing it which would require the use of dimensions—that is, feet, inches, or millimeters.

The CHAIRMAN. Supposing the Government wanted a sewing machine, would they order it in measurements?

Mr. TAYLOR. Yes. They would advertise in the same way.

Mr. DRESSER. Suppose they wanted an article on the market, would they not mention the catalogue number?

Mr. TAYLOR. No; they would advertise in general terms describing the exact article which they wished to buy by its particular characteristics. If there were any sizes by which it could be identified the dimensions would be advertised, and such dimensions would be given either in inches or in millimeters, according to the unit the Government was at the time employing. At the present time, for instance, as patentee I am interested indirectly in the manufacture of a certain saw for sawing iron and steel forgings and castings, etc., which the Government purchases. In ordering this saw they, however, would not refer to our catalogue number, but they would buy it by first asking for bids, giving the dimensions of the saw which they wished.

The CHAIRMAN. Did they describe the saw you make?

Mr. TAYLOR. Yes.

The CHAIRMAN. Is it a standard size?

Mr. TAYLOR. Yes.

The CHAIRMAN. In furnishing that saw to the Government, what extra expense would you be put to?

Mr. TAYLOR. I do not know exactly what you mean.

The CHAIRMAN. Suppose the Government ordered that saw from you and this bill pending here should now be passed, what extra expense would it be to you?

Mr. TAYLOR. If the Littauer bill became a law, the Government would be obliged to advertise for the saw which they wanted, not in the manner in which it is described by the maker, but they would have to speak of it as so many millimeters in diameter and so many millimeters in thickness, having teeth so many millimeters wide, etc., and on receiving such an advertisement or request for a bid we should have to translate all of those measures into inches in order to find out, then, whether we made such a saw or not.

Mr. BOWERSOCK. You make those saws in different sizes?

Mr. TAYLOR. Yes, sir.

Mr. BOWERSOCK. Have they any numbers?

Mr. TAYLOR. Yes; they are known as, say, 26-inch saws, having wide teeth three-eighths of an inch in width.

Mr. BOWERSOCK. The Government already has some of your saws?

Mr. TAYLOR. Yes.

Mr. BOWERSOCK. And the Government needs more of the same size. Would you have to make translations to fill an order under such circumstances?

Mr. TAYLOR. Yes. The Government would advertise for those saws in the metric system and we would have to translate their advertisements into inches.

Mr. BOWERSOCK. The American workingman is perhaps as intelligent as those in any other country, is he not?

Mr. TAYLOR. Yes; I think so.

Mr. BOWERSOCK. What system, if you know, is used at the great works in Essen, in Germany—the great Krupp works?

Mr. TAYLOR. The metric system.

Mr. BOWERSOCK. How did the workmen come to take that system there? How long were they in taking it? How were they able to take it up?

Mr. TAYLOR. Do you want me to go into a disquisition on the Germans?

Mr. BOWERSOCK. No.

Mr. WOOD. How long have they had it?

Mr. TAYLOR. Since 1872, I believe. At that time, however, the industries in Germany were comparatively small. Germany was then much smaller as a manufacturing country than she is now. At that time one could hardly travel 100 miles in Germany without coming into a section of the country using some new unit of measure. There were half a dozen different sets of inches and feet in Germany, and there was perfect chaos there in the matter of standards of measure. Any system under the sun adopted throughout the country would have been an improvement upon the many systems which they then had. The Chinese system, even, would have been an improvement upon that terrific state of things.

The CHAIRMAN. Do you know General Crozier?

Mr. TAYLOR. Yes.

The CHAIRMAN. Do you understand he has advocated the introduction of the metric system for the Government?

Mr. TAYLOR. I am surprised to hear it, because I know Crozier is a mighty bright fellow. I am not surprised to hear that he uses the

metric system in many of his calculations. I doubt, however, whether he has ever worked as a workman or come into intimate personal contact with the workmen in their daily use of the inch as a standard of measure.

The CHAIRMAN. You have not told us what the extra expense would be to you to furnish these saws and any other articles furnished to the Government.

Mr. TAYLOR. You mean to inquire what would be the extra cost to us if the Government made a design of one of our saws and ordered it from us. In that particular case, if the design did not suit the machines and the apparatus which we have for making our saws, we would decline to fill the order.

The CHAIRMAN. Suppose the order was in metric language; what would it cost you, in money or anything else, to duplicate that saw or anything else you manufactured?

Mr. TAYLOR. If the Government in their advertisement called for a saw—one of our standard sizes, which we had made and kept in stock—we would be put to the inconvenience of translating the dimensions given in millimeters in the Government advertisement into the language of inches and then translating back again in writing and corresponding with the Government.

The CHAIRMAN. You will still use the United States standard?

Mr. TAYLOR. Of course, if the Littauer bill is passed the Government can use the millimeter in describing the dimensions, and, in fact, will be forced to do so, and yet all the while workmen who are making the materials called for by the Government will be making United States standard screw threads, for example, in inches. It will be simply the name that is changed; not the actual sizes.

The CHAIRMAN. Is there any project here contemplating a change in standard threads?

Mr. TAYLOR. I think it is the general understanding of all those to whom I have talked regarding the Littauer bill that it is intended as an entering wedge, with the ultimate intention of jamming the metric system of measures upon the people of this country—who do not want it. I understand that to be the ultimate object of those who are advocating this bill.

Mr. BOWERSOCK. I feel that you are fully as much mistaken in the assertion you are just making as you are in any other promises you have laid down here.

Mr. WOOD. He is an expert on the matter and that is his opinion. He is just expressing his opinion.

Mr. TAYLOR. I do not, of course, claim infallibility, but I have a very distinct, strong opinion on this subject.

Mr. DRESSER. I was going to suggest, with reference to this saw matter—it is an ordinary, plain, common-sense proposition—that when he sends an invoice of saws he makes an invoice of it, and that invoice gives a number in all human probability, and gives a size, and when the Government wants to order more of those saws it wants simply to duplicate that order, and the manufacturers would not be subject to any expense whatever from the change.

Mr. TAYLOR. As I have said before, gentlemen, I have had very extensive dealings with the United States Government. The Government insists on ordering the articles which they want in their own language and not in the language of the manufacturer, and in rend-

ering a bill the manufacturer is obliged to use the Government's language and not his own. Otherwise, the Government would return the bill to the manufacturer, asking it to be corrected. In other words, if the Government orders an article of any kind in a certain language you must deliver the article in the same language.

The CHAIRMAN. Your notion is that if this bill were to become a law, if the Government wanted a sewing machine, or an engine, or a saw, or a lock, it would make out the specifications in metric language and send them in to you?

Mr. TAYLOR. Of course they would.

Mr. DRESSER. I believe like my friend, Mr. Bowersock, and I differ with you. I am a manufacturer of pipe, and I send out pipe to individual users of pipe, and I have a catalogue, and when they order from me they take my catalogue and give me the number and size they want. If it is 4 inches or 6 inches or 10 inches or 12 inches, they give me the order for that size from my catalogue.

Mr. TAYLOR. Have you ever sold any pipe to the Army or Navy Departments?

Mr. DRESSER. I do not know that I have.

Mr. TAYLOR. If you had, you would know that I am right, and that in asking for bids for pipe the United States Government would now state the diameter of the pipe in inches and give in addition the thickness of the walls of the pipe, and probably also, if it were for a very important use, give a specification stating the bursting pressure it would have to stand.

The CHAIRMAN. I will read from General Crozier's testimony in the old hearings. General Crozier said:

I take a rather conservative view of the subject. I think the change is desirable, but I can not go as far as some of my friends in considering that the need for it is as pressing as they think.

Mr. WOOD. He does not concede the need as pressing.

The CHAIRMAN. He says further:

We sometimes use the foot, but we never use the yard, and we usually use the inch and the decimal of an inch. So that changing to the metric system would not be a very great change in that respect, and correspondingly would not give us a very tremendous advantage over our present system.

Is there any other question anybody wants to ask of the witness?

Mr. TAYLOR. I would like to have a talk with Mr. Crozier. [Laughter.]

Mr. WOOD. General Crozier says here:

I can not go as far as some of my friends in considering that the need of it is as pressing as they think.

That is a qualified statement.

Mr. BOWERSOCK. I would like to emphasize this point, that this gentleman states there were several inches in Germany. That may be the case, but in some of the factories in Germany, manufacturing complicated machinery, they had a certain inch, as we have, which was the property of the machinists and workingmen, in the same sense as the inch is the property of those in this country, and yet they adopted the metric system satisfactorily and successfully.

Mr. TAYLOR. Not to the extent of one-half is the manufacturing now done in Germany under the metric system.

Mr. BOWERSOCK. Those great Krupp Works, the largest in the world, are working under the metric system.

Mr. TAYLOR. Yes. The Krupp Works, as is well known, is at least a semigovernment establishment, and probably they are forced to use the metric system there more than any other works in Germany; but, on the other hand, Mr. Ambrose Swasey, a member of the firm of Warner & Swasey, of Cleveland, and a former president of the American Society of Mechanical Engineers, told me this morning that last year they sold $500,000 worth of their machines abroad, and of their machines that went to Germany only one-fifth went with the metric standard measures in the screw threads, and four-fifths went with the English standard, showing the extent to which the English standard is used in Germany.

The CHAIRMAN. How about the metric system in this country?

Mr. TAYLOR. I do not know.

The CHAIRMAN. A general appraiser said that 75 per cent of our imports came in metric weights and measures.

Mr. TAYLOR. I am talking about the machines which are used by Germans themselves in manufacturing the products which they sell. The leading screws of the machines shipped by Mr. Swasey show that the people in Germany who bought those machines proposed to manufacture in inches, not in millimeters, and thus demonstrate the fact, as Mr. Swasey told me, that they are not in Germany at the present time more than one-half using the metric system.

The CHAIRMAN. Is the metric system compulsory there?

Mr. TAYLOR. It is, and there is a law there, I believe, making its use obligatory, and yet they don't use it.

The CHAIRMAN. You are talking about Germany now?

Mr. TAYLOR. Yes.

The CHAIRMAN. It is compulsory there?

Mr. TAYLOR. I believe so.

The CHAIRMAN. Now, if a law fixing a penalty does not compel the manufacturers in the metric system, how do you fear or why do you fear the system is going to be jammed upon you here when there is no talk of any legislation of that kind?

Mr. BOWERSOCK. And no penalty attached.

Mr. TAYLOR. I do not fear it will be jammed upon us, because the moment it touches the workingman it will be repealed and go out of existence. What I fear is that an attempt may be made to jam it upon us. However, just let the manufacturers, the people who do the work of this country, understand for a minute that this is really contemplated, and you will see what will happen to this committee. You will be overwhelmed with men who wish to stop this folly. [Laughter.] Every one who knows anything about this bill and its objects realizes that it is intended simply as an entering wedge, with the object of ultimately forcing the metric system upon this country. I use the word forcing, because, as you all know, at this time anyone who wishes to use the metric system is at perfect liberty to do so. I use it myself in many of my calculations, and would raise Cain if anyone tried to prevent me from using it when I wished to do so. I am not kicking, gentlemen, against the metric system; I am kicking against making the workmen of this country use what is and will always remain to them a perfect absurdity. It would be perfectly ridiculous to force the metric system upon them, just as ridiculous as

it would be to make you, gentlemen, call this thing I am sitting on, not a chair, but a chaise, and to call this carpet, not a carpet, but a tapis. You are any of you now at liberty to call it whatever you please, but it would be perfectly preposterous for the Government to order you to call a chair or a carpet by new names.

Mr. DRESSER. If you were brought up to call that a chaise it would be all right, would it not?

Mr. TAYLOR. No doubt.

Mr. DRESSER. There is another point in connection with that, and it seems to me it is very forcible. There was a time in this country in connection with this very simile which the speaker has used twice—there was a time when we talked about a "fip" and a "bit," and when the people who traded counted nothing but shillings and so on, and by law that was changed, and changed readily and easily and without very much friction. When I was a boy, the "fip-and-a-bit" and the shilling were common things to talk about.

Mr. TAYLOR. Go ahead, if it is necessary for you to do something, and alter our system of weights if you wish to. There will be very little kick coming from our workmen on that score. A mechanic could use a new standard of weights without very tremendous or serious inconvenience. In fact, the standard of our weights could be changed in a comparatively short time, and this would cause no very great inconvenience, but gentlemen, I warn you, do not touch the standard of linear measure. The inch is woven into the very warp and woof of the country.

Mr. WOOD. You think the manufacturers of the country do not realize that there is any danger of this bill passing?

Mr. TAYLOR. No. I think that nine out of ten of them who have heard about the matter at all take the same view that I took when I was asked time and again to come here. I said, "Oh, what is the use? There is no chance of that bill passing." Finally, however, as president of the American Society of Mechanical Engineers, I received perhaps 50 letters from members of our society and from those who have taken the greatest interest in its welfare, namely, the past presidents and other officers, asking me to come here. For some time I declined to do so until several of the past presidents of our society came to see me. Among them Mr. Swasey came from Ohio.

Mr. WOOD. What is his position?

Mr. TAYLOR. He is one of the firm of Warner & Swasey. They make machine tools and also fine telescopes and optical instruments.

Mr. WOOD. He has expressed himself, within a day or two, as being vigorously opposed to this bill?

Mr. TAYLOR. Yes. This morning I sat down with him for an hour or two at the Willard, and he said:

For goodness sake, Taylor, tell those gentlemen what they are going to do. They don't know it.

The CHAIRMAN. The fact remains that after a notice of two years they did adopt without any considerable friction the use of metric weights and measures in Germany, does it not?

The CHAIRMAN. Of course they appointed a commission to consider the matter in 1860, and then in 1871, as I understand it, they passed a law, according to my recollection, to the effect that within

two years from that time the use of the metric weights and measures should be compulsory; and it is a fact, is it not, that after they adopted the law at the end of two years they went to the use of the metric measures without any trouble?

Mr. TAYLOR. In Germany they adopted without trouble new measures of value—that is, a new currency, and also new standards of weights—but, as I have tried to tell you several times, they have not even up to this date adopted the metric measures for length. After thirty-odd years they are not more than half in use, and they never will be in full use.

The CHAIRMAN. There is a great contention about that.

Mr. TAYLOR. There will be comparatively little kick coming from anyone if you try to alter the measures of capacity, because whether the man uses a quart measure or a liter he is not seriously inconvenienced. He is in very much the same position as the very exceptional workman whom I spoke to you about, who does the same kind of work from year end to year end and who uses an actual solid metal gauge to measure his work with. A man of that sort does not know whether the gauge measures in inches or in millimeters, and therefore is but little inconvenienced.

The CHAIRMAN. And the great majority of manufacturing, especially manufacturing in standard sizes, is done that way?

Mr. TAYLOR. No, sir. If you will go over all this country you will find that not one man in a thousand is working in that way. A portion of the work done in the Baldwin Locomotive Works is the only place that I now think of in which the work is done in that way. I know of no other locomotive works where they work in that way. The Baldwin Locomotive Works are able to do it, as I said before, because, having 15,000 employees, they are able to subdivide their work into exceedingly small sections.

The CHAIRMAN. Do you not do it in every case when you manufacture a standard machine?

Mr. TAYLOR. No, sir.

Mr. TAYLOR. No, sir.

The CHAIRMAN. When you manufacture, we will say, a milling machine? I understand there is a manufacturing firm in Cincinnati who manufactures those machines——

Mr. TAYLOR. Yes; Warner & Swasey, the latter being the gentleman whom I saw this morning. (In making the above answer I misunderstood the chairman and thought that he said Cleveland instead of Cincinnati. Messrs. Warner & Swasey's shop is in Cleveland.)

The CHAIRMAN. Yes. They manufacture about 15 different sizes of milling machines. Is it not a fact that when they determine to manufacture a certain size of milling machine they go to work to get their gauges and templets and fixed tools to manufacture that machine?

Mr. TAYLOR. I understand that they do in some cases.

The CHAIRMAN. Is not that the cheapest and best way?

Mr. TAYLOR. Not in one case out of a thousand. One has to be sure of an enormous business in order to warrant one in doing that. The manufacturer has to be sure that the machine he has to make is in large demand before he can afford to manufacture in that way and that the demand for it will last several years.

Mr. DRESSER. The wire gauge comes in for use on an enormous scale?

Mr. TAYLOR. Yes.

Mr. DRESSER. And it is used in many machines and is used for fixing the size of iron and bolts?

Mr. TAYLOR. Yes. Of sheet iron and for very small bolts. This, however, forms but a very small portion of the iron products of this country.

The CHAIRMAN. So that in manufacturing in different sizes they would not prepare their gauges and jigs and things to put into the hands of workmen to reproduce the parts?

Mr. TAYLOR. I feel very sure that the greater part of the manufacturing done in Mr. Swasey's works is done by men who have to continually use their rules in measuring accurately in inches.

The CHAIRMAN. I would like to read you from Mr. Lodge's testimony——

Mr. TAYLOR. Of the Lodge & Shipley Machine Tool Company?

The CHAIRMAN. Yes.

Mr. TAYLOR. Messrs. Lodge & Shipley are manufacturers of lathes, which they make in very large quantities. They turn out a uniform and very fine lathe and do it on a manufacturing basis.

The CHAIRMAN. That is not the Cincinnati Milling Machine Company, is it?

Mr. TAYLOR. No.

The CHAIRMAN. Mr. Lodge filed a carefully prepared statement, in which he said:

> Take for example the Cincinnati Milling Company, who make 14 different sizes of machines, and according to the above figures these fixtures will aggregate a cost of $77,000.

And he says in his testimony, and the testimony of other people is to that effect, that in manufacturing these standard machines and tools, and so forth, they make their jigs and their templets and their gauges and put them in the hands of the workmen, who manufacture according to the great American plan of interchangeable parts.

Mr. TAYLOR. Some do.

The CHAIRMAN. And they say that is the great distinguishing feature between the manufactures of this country and those abroad, and that we manufacture so much more cheaply than they because we manufacture in interchangeable parts, and we can do that because we can use these special tools. That fact is dwelt upon and dwelt upon by engineer after engineer and manufacturer after manufacturer who came before this committee, and their insistence is that notwithstanding the fact that they manufacture standard sizes and notwithstanding the fact, as I understand it, that the Government will order these standard sizes, they will be put to the expense of changing these gauges, these templets, these jigs, these small tools, which amount up to this enormous sum in the advance business of every manufacturing institution.

Mr. TAYLOR. I have repeatedly said that the effect of the Littauer bill will be to cause our Government departments to adopt what I call a fake metric system, in which inches will be the real standard of measure but in which metric names will be used in the place of these inches. If, however, our Government departments were to adopt the genuine metric system and were to demand that machines and product used

by them should be actually designed and made under the genuine metric system, in that case our makers would be obliged to throw away the jigs, etc., which they now have and which are made under the inch system. Now, gentlemen, I have not the slightest doubt that those of your committee who favor the adoption of the metric system in our departments wish the adoption of the genuine metric system (not the fake adoption which I predict the departments will be forced into in case this bill passes); and the moment the metric system is genuinely adopted in this country then these jigs and fixtures must be thrown away.

The CHAIRMAN. You do not tell me that the Government would redesign any standard machine made by any manufacturer?

Mr. TAYLOR. I say without hesitation that if there is any real, sane motive back of this Littauer bill it is for the purpose of forcing the adoption of the metric system upon this country and that, of course, means the redesign of our machines in metric units.

Mr. WOOD. As a practical man you see no reason for impeaching the testimony of Mr. Lodge in the statement he made here?

Mr. TAYLOR. Not the slightest.

The CHAIRMAN. If there are no further questions, the committee will stand adjourned.

Mr. WOOD. I move that Mr. Henning and Mr. Taylor be given a vote of thanks for their testimony before the committee this morning.

The CHAIRMAN. It has been moved and seconded that Mr. Henning and Mr. Taylor be given a vote of thanks for appearing before us to-day. All in favor say "Aye;" contrary "No." The ayes have it and the motion is carried.

Mr. TAYLOR. Mr. Chairman, if I have been too emphatic this morning I beg pardon. I did not intend anything except to be courteous.

STATEMENT OF MR. FRED G. R. GORDON, REPRESENTING L. S. STARRETT FINE TOOL MANUFACTURING COMPANY, OF ATHOL, MASS.

Mr. GORDON. Mr. Chairman and gentlemen, I live in Reading, Mass. I represent the L. S. Starrett Fine Tool Manufacturing Company, of Athol, Mass., and between 400 and 500 workingmen employed by them. I occupy the unique position, perhaps, and am very proud to occupy that position, of representing equally the working people who perform the labor in those mills and the manufacturer who for twenty-five or thirty years has been building up what is now the mainspring of a town of 9,000 population.

Mr. WOOD. What is the character of the manufactory?

Mr. GORDON. Fine tools of all kinds.

The help and the firm itself, including, of course, the skilled people who are employed there, the superintendents, foremen, and engineers, and so forth, are absolutely and unqualifiedly opposed to this pending bill. They are opposed to it because they believe that it is the entering wedge that will bring about the adoption of a system that they can not conceive to be any better than the present system, and it has no advantages as a whole over the English system. They recognize that this nation is the foremost manufacturing nation of the world; that, together with Great Britain, we manufacture more commodities of all kinds and descriptions than all the rest of

the world put together. I spent six years working for the largest textile corporation in the world. That is the Amoskeag Cotton Corporation, in the city of Manchester. Out of 110,000,000 spindles in the greatest manufacturing industry of the world, 70,000,000 are in Great Britain and the United States. I refer to the textile manufacturing industry. They recognize that practically all the manufacture of cotton and woolen goods is in the system we use, and that that is going to continue, whatever action this committee may take. Furthermore, they believe that this bill will impose, if it becomes a law and the established custom of the nation, a burden upon mechanics; that it will compel the workingmen to go down into their pockets to the tune of anywhere from $20 to $50 apiece to buy new tools, making, I suppose, in the aggregate $100,000,000.

The CHAIRMAN. Tell us how that could happen.

Mr. GORDON. A great many mechanics of all kinds, carpenters and machinists and that sort of thing, buy their own tools. I asked the superintendent of the L. S. Starrett Company, in the presence of half a dozen mechanics, to tell me as near as possible, if this thing became the established standard of the nation, what it would cost the people who had to buy their tools, and he said anywhere from $20 to $50. "Now, then," he said, "there is what we sort of call the 'crank,' who would pay from $100 to $150 for his tools; of course it would cost him much more, but that would not be the average."

Mr. BOWERSOCK. As a practical man, what is your opinion, based upon this bill, as to the expense it might involve to these workingmen? Let us have your candid opinion.

Mr. GORDON. Under this particular bill?

Mr. BOWERSOCK. Yes.

Mr. GORDON. Well, I have to confess, gentlemen, that I did not come before this committee as a scientific man, because I was unfortunately forced to go into a cotton mill to work at the age of 14 years, and I have been working ever since; but if after the 1st day of July, 1908, this Government lets a contract to build a war vessel at Newport News, to the Newport News Shipbuilding Company there, or whatever the name is, and this bill becomes a law, out of the 6,000 people who are employed in these works probably 2,000 are to work upon this particular ship, I venture to say—well, I might almost say—that the doctrinaires, scientific men, who are not very often practical men, that they will, as a matter of fact, live up to the letter of this law and compel all measurements and weights to be taken in this system, which is a sort of hobbyhorse—not with this committee, I do not mean to say, but with them——

Mr. BOWERSOCK. You are talking very entertainingly, but get down to the point——

Mr. WOOD. Can he not tell it in his own way?

Mr. BOWERSOCK. I would like this point. You know what the carpenter's tools are?

Mr. GORDON. No; I am not a carpenter.

Mr. BOWERSOCK. You were referring to the opposition of the workmen on account of the cost that would be necessary by reason of having to buy new tools. Now, in your judgment how much would a carpenter have to change his tools or a blacksmith or any other mechanic?

Mr. GORDON. Most every carpenter who has any pride at all in his skill in his occupation, or a machinist—any mechanic has pride in having very fine tools or nice tools. I have seen them have little spuare, 3 inches, that cost $6. You can not change that to the metric system on this war vessel——

The CHAIRMAN. Do they have carpenters on a war vessel?

Mr. BOWERSOCK. Rules might have to be marked differently, but how about the saw and the plane and the chisel?

Mr. LILLEY. The chisel is an inch.

Mr. BOWERSOCK. Not necessarily.

Mr. GORDON. But there are a number of tools. I have in my possession a catalogue marked by the superintendent, who is a graduate of the Massachusetts Institute of Technology, and who is a thorough-going workman. He has spent years with this firm I represent. He has made a list of a number of tools, I don't know how many, but a good many that would, if this thing became the established standard of this country, have to be thrown away.

Mr. KNOWLAND. This goes into effect in 1908. By that time I imagine they would want to get a good many new tools. Tools do not last forever, do they?

Mr. GORDON. They would last much longer than a year or a year and a half.

The CHAIRMAN. You would hardly expect it would come into general use throughout the country right away?

Mr. GORDON. No; but this firm I represent has 2,000 show cases in this country, and in those show cases we have $200,000 worth of fine tools, and upon the shelves of their factory and in their storeroom in the little town of Athol, Mass., and their wholesale jobbing houses in New York and Chicago they have $500,000 worth of these fine tools, all in the English system, stacked upon the counters of those places to-day.

The CHAIRMAN. What effect would this bill have upon those tools?

Mr. GORDON. Possibly, if the carpenters——

The CHAIRMAN. Tell us probably what would be the effect.

Mr. GORDON. I am trying to tell that. If the people who buy tools thought that this was to become the standard of the country they probably would not be very active in buying any more tools. Mr. L. S. Starrett, who is also a thorough-going mechanic and a graduate from a college, and a man who spent twenty-five years in practical work, tells me that he believes 75 per cent of that vast amount of property that is stacked up here would be a loss. I have a statement from him in my pocket, in which he declares that the general adoption of this bill would cause his firm to lose enough so that it would probably ruin his business. That is the way he feels about it.

I would like to make one more point, and it will only take me a second or two. I want to say this: I am opposed to strikes; I am opposed to radicalism; I am opposed to too much government. The trouble is we are going pretty rapidly toward socialism, and I am going to combat that in the future as I have in the past. Now, as to strikes, this bill would be one of the greatest strike breeders that would be possible to enact. The workmen will not try to learn this new system. You go out into the shops and factories and ask them this question and you will find that they do not want this system. Mr. Littauer's people themselves do not want this thing. The secretary

of the International Glove Workers' Union told me personally he would protest against this, and that all their people would protest against it, although they are using it. If a man wants to use this in his factory there is nothing to prevent it. My friend here can adopt it for his factory; I can reject it. Why force us into using it if we do not want to?

Mr. BOWERSOCK. Does not the tool concern with which you are connected use both of these systems now?

Mr. GORDON. We have three men in the factory who can measure up things in the metric system, and they are prepared to fill orders in the metric system.

Mr. BOWERSOCK. Just as readily as any other?

Mr. GORDON. I suppose so, but they object very strongly to this bill and the form in which it is drawn.

The CHAIRMAN. I do not like to cut you off, and if you would like to supplement what you have said by any statement you may give it to the stenographer.

Mr. GORDON. I will be glad to make a statement if the gentlemen desire. I am very greatly obliged for the opportunity of addressing the committee.

STATEMENT OF MR. WILLIAM KENT.

Mr. KENT. I would first like to qualify as a scientific man with academic leanings.

The CHAIRMAN. That does not bar you here.

Mr. KENT. I am a member of the American Association for the Advancement of Science, and have been since 1877, and was once one of the vice-presidents. At present I am dean of the College of Applied Science of Syracuse University.

I wish first to pay my respects to the eminent enterprise of the New York Herald. A reporter came to me from that paper a short time ago and asked me if I would not be good enough to give him an interview on the metric system. I said: "Here, I have it all in print; if you will kindly read it I will be very much obliged." He looked at it and he said: "I do not think we want to print anything of that kind. We are looking for something on the other side." [Laughter and applause.] He went through our college and tried to get signatures to a petition, and he did get three professors to sign a petition in favor of this Littauer bill. I was not aware of that until several days ago, and I got a clipping, and I thought that we had better get an antidote to that, and I sent around to the professors and here is the result. I hand you a petition against the Littauer bill, signed by all the professors in this college except those three.

I have also here a letter and two telegrams, which I got this morning from Syracuse manufacturers, asking me to present their protests against the Littauer bill.

Until within the past few years the advocates of the metric system have been trying to get through Congress legislation compelling the people of the country to use the system. A few years ago the bill stated that from and after a certain date the metric system should be the only legal system used in the United States. Two years ago the

bill stated not that it should be the only system but that it should be the system. The discussion on these bills seems to have awakened the metric advocates themselves to the knowledge of the fact that it is impossible to force the metric system on the people of this country by compulsory legislation. It has also made them aware of the tremendous damage it would be to the manufacturing interests of the United States to compel them to throw away their standards of measurement of length, which are based on the English inch. The metric advocates know that if they succeed in getting a report by this committee in favor of a bill for compulsory use of the system and a bill which would compel the abandonment of old standards, it would meet with overwhelming defeat in the House and therefore after learning this lesson the metric advocates have introduced this very mild, sugar-coated homeopathic bill, which provides that the Departments of the Government shall use the metric system, not necessarily in their work of construction or design or experiment or manufacture, but only in the transaction of business requiring the use of weight and measurement, leaving it to the future to determine just what those words, "transaction of business," mean.

The leaders among the metric advocates are making a strong point of the fact that this bill does not tend to change the old standards. As the chairman of this committee says, in a recent letter to Prof. John E. Sweet:

> If the Government desired to purchase a Wilcox & Gibbs sewing machine they would purchase it by number and in the same way they would purchase it to-day. There would be nothing to cause a change in the machine, and they could not make it with other tools. It would be the same with an engine, a machine, tools, or other supplies that the Government might wish to purchase. Any standard machine that had been built for twenty-five years could be built for twenty-five years more, so far as I can see, without changing a drawing, pattern, or tool, or anything entering into the construction of the machine. The statement that large expenses and inconveniences would result arises from this assumption that manufacturers will at once abandon their present standards, involving plans, drawings, tools, etc., in order to make the change to even metric sizes. You will agree with me that this would not happen.

So the metric advocates are trying to make this bill pleasant for everybody to swallow. "It is only a little one," they say, "and will do no harm." But one of the strongest advocates of the system, John Elfreth Watkins, of Washington, in an article in the Washington Evening Star of March 24, describes the result of the bill in these words:

> If the bill passes, however, all Government business requiring the use of weights and measures will be transacted on the metric basis, tobacco and whisky will be taxed by the kilogram and liter, mail matter will be weighed in grams, official charts will indicate distances in kilometers, and so on. Its adoption for all Government purposes, of course, would mean a speedy ramification of the metric system throughout the entire country, and it would be voluntarily adopted for their private transactions by all citizens mastering its simple elements sufficiently to give it a fair comparison with the cumbersome, devious, and complicated English system.

If the adoption for all Government purposes would mean a speedy ramification of the metric system throughout the country, as Mr. Watkins says, and if, as Mr. Southard says, the adoption of this bill would not compel any manufacturer to change a single drawing, pattern or tool, or anything entering into the construction of a machine, or cause them to abandon their present standards in order to make the change to even metric sizes, then what would happen

would be the sum of what Mr. Watkins says and what Mr. Southard says, namely, two systems existing side by side. The metric system would be ramified throughout the country and the manufacturers would keep making things on the old system. Do any of the metric advocates really understand what this means? Here is an example which may enlighten them. It is an example which can be solved by any child who has studied weights and measures and knows anything about the weight of iron.

What will a bar of iron 1 by 4 inches, 20 feet long, cost at 2 cents a pound?

The only figure to be remembered is that a square foot of iron 1 inch thick, weighs 40 pounds, and the solution is as follows:

1 bar 1 x 4 in. × 20 ft. = 6⅔ sq. ft. × 40 = 267 lbs. × 2 = $5.34.

Now the manufacturers will continue to produce bars of 1 inch by 4 after the metric system has ramified itself throughout the country and the Government will continue to buy these bars, although under the law they may call them by metric names. The calculation of the cost of such a bar under the new law would read as follows, 7.7 being the specific gravity of iron:

1 bar 25.4 x 101.6 mm. × 6.096 m. = 157,316[a] × 7.7 = 121.1 kilo. × 4.408 = $5.34.

But after a while, according to Mr. Watkins, when the citizens had begun to adopt voluntarily the metric system, bars in even metric sizes would be rolled and they would be called bars of 25 by 100 mm., and it would be near enough to the 1 by 4 inch bar for 99 per cent of all the cases that occur in practice, but some people would still order that bar 20 feet long. Others would order it 6.096 meters long. Some people would make their drawings in the even metric measures and would call for this bar to be given exactly 6 meters long. So the orders and the bills might read as follows:

1 bar 25 x 100 mm. × 6.096 = 15240 × 7.7 = 117.4 kilo × 4.408 = $5.17
1 bar 25 x 100 mm. × 6 = 15000 × 7.7 = 115.5 kilo × 4.408 = $5.09

All manufacturers, designers, architects, and engineers who have to do with iron bars use tables of weights, which save a lot of trouble in calculation. In the English system in calculating the above example the designer would refer to the table and find that inch by four bar weighs 1.335 pounds per foot. He would multiply this by twenty and a 20-foot bar would weigh 267 pounds. But after the metric system had ramified itself throughout the country instead of this one table of weights of flat bar iron in English sizes there would be needed eight tables, as follows, namely, two different sizes of bar, each with four different ways of expressing its weight per unit of length.

Tabular values of weight.

American standard size:
1 in. x 4 in. bar iron = 1.335 lbs. per ft. = 0.605 kg. per ft.
25.4 x 101.6 mm. bar iron = 4.378 lbs. per meter = 1.987 kg. per meter.
French standard size:
25 x 100 mm. bar iron = 1.925 kg. per meter = 0.587 kg. per ft.
0.984 x 3.937 in. bar iron = 4.243 lbs. per meter = 1.293 lbs. per ft.

There would also be two price tables—cents per pound and per kilogram. Can it be conceived by any sane man that the English-

[a] What denomination is this? What shall the decimal point be?

speaking people as a whole would voluntarily abandon the existing system, which is more suitable to their uses than the metric system is, and deliberately involve themselves in such an inextricable confusion as the solution of the above example shows forth?

I have here a printed report of the last annual meeting of the National Fire Protection Association, which gives the report of a committee on the standard sizes of threads for hydrants and hose couplings, which states that for thirty years people have tried to standardize them and could not, because one city had one size and another city had another size, and still a third city would have a different size, and they did not seem to be able to get together and get a standard. This committee went through all the principal cities and measured the sizes in all the different places, and at last they made this report. The object of a standard fire hose and hydrant couplings is evident, and the trouble arising from the nonexistence of a common standard throughout the country was shown in the Baltimore fire, where the New York and Washington fire engines could not help at all unless they could get to the river and pull the water directly out of the river.

The CHAIRMAN. The question of a standard is quite distinct from the question of measurements.

Mr. KENT. I will admit that. The chiefs of the fire departments and the fire engineers of the country have agreed on this standard and it will be unanimously adopted everywhere, if it has not already been so. The inside diameter of the hose is made 2½ inches, 3 inches, 3½ inches, and 4½ inches. The number of threads per inch has been made 7½ for the 2½-inch coupling. Under the conditions as they have existed some have used 7, some 6½, and some 8; and they have used all kinds and sizes of threads. Now they have agreed that they will all come to that set of standards. They will remain as standards based on the English inch, will be called by the names 2½-inch, 3-inch, etc., and will never be changed to metric sizes or called by metric names.

I have a few object lessons here to show what American mechanics do with the English inch in decimal measures. Here is one of L. S. Starrett's micrometer screws reading to ten-thousandths of an inch, and here is a brass bar of four different diameters in different parts of its length—one part of half-inch diameter, and the other parts, respectively, one, two, and three ten-thousandths larger than the half inch. The gauge, which just fits the half-inch part, you can observe, does not fit the part that is one ten-thousandth of an inch larger. Every fine machinist in the United States has one or more of these measurements. He uses them and makes calculations to the one-thousandth or ten-thousandths of an inch just as well as anyone would do with the metric system.

The other exhibit which I have is four reference books, used generally by the engineers throughout the United States, and called reference books, or pocket books. The first is Trautwine's Civil Engineers' Pocket Book, first edition published in 1876, and the copy I have is the eighteenth edition, seventieth thousand, published in 1902; the second is Foster's Electrical Engineers' Pocket Book, the first edition of which was published in 1901; the third is Supplee's Mechanical Engineers' Reference Book, published in 1904, which is largely a reprint of Nystrom's old pocket book, first printed in 1854;

and the last is my own pocket book for mechanical engineers, first published in 1895 and now in its eighth edition, fortieth thousand.

All of these pocket books treat to considerable extent of the metric system, and each of them uses it in places where its use appears advisable. Let these books be carefully examined by anyone who thinks that it will be an easy matter to abandon the use of the English inch and he will soon be convinced that it is no more possible to abandon the English inch than it is to abandon the English language. It is quite possible, however, to introduce confusion into our system of weights and measures, and this is really the whole question to-day before the committee. Will they advise the House that it is for the benefit of the people of the United States that they be further educated in the metric system by the means proposed in this bill, even at the cost of great trouble to the Government Departments themselves and to the people who have business with these Departments? Will they say that it is for the benefit of the people of the United States that they should have for generations to come two systems of weights and measures side by side for the same purposes in the same kinds of business, or will they not rather say that all this confusion and trouble and expense can be avoided by leaving this whole matter to the judgment of the individual citizen without any attempt at legislation about it? Why should this bill be passed? For whose benefit is it, and for what end? It will confessedly entail upon the Government a great expense and trouble, and it will make trouble for everyone who bids on a Government contract. It will cause the Government to use in all its commercial transactions a different language from that of the people.

Why should Congress pass a law not demanded by the Departments or by the people, which will give to the Government, and to those who deal with the Government, so much trouble with no compensating advantage whatever, simply because the metric advocates—a very small fraction of the people—who have been conducting a metric propaganda for thirty years, wish the Government to undertake the education of the people in the system of weights and measures which the people do not want? They wish, as they say, to try it on the dog.

John Quincy Adams, in his report in 1821, said:

> The power of the legislator is limited over the will and actions of his subjects. His conflict with them is desperate when he counteracts their settled habits, their established usages, their domestic and individual economy, their ignorance, their prejudices, and their wants, all which is unavoidable in the attempt radically to change or to originate a totally new system of weights and measures.

I respectfully urge the committee to bring in a strong adverse report on this bill. One so strong that it will stop the efforts of the advocates of the metric system from attempting to get any more legislation in favor of their chimera for the next generation.

As I have not been allowed sufficient time to make a lengthy oral presentation of the case against the metric system, I have prepared with some care an argument which I present here in typewritten form, and which I respectfully ask the committee to include in the printed report as part of my remarks.

The typewritten pages referred to were mailed to Mr. Southard on April 6.

AN ANSWER TO THE ARGUMENTS OF DOCTOR STRATTON BY F. E. CARDULLO, INSTRUCTOR IN MACHINE DESIGN, SYRACUSE UNIVERSITY.

The advantages claimed for the metric system by Doctor Stratton in his argument before the committee on March 1 was summed up by himself as follows:

1. The metric system is simple.
2. The metric system is a decimal system.
3. The metric system is international in character.

Taking up these arguments in their order, I would say that while it is true that the metric system is simple in practice our own is equally so, and that the simplicity of the metric system is no argument in favor of its adoption, unless the system of mechanical instruments which would result from its adoption would be more simple than our own. In the first place, I say that our own is equally simple with the metric, for the reason that we have a particular unit for each particular service, and it is but seldom that we are called upon to reduce from one unit to the other. Our surveyors do all their work in feet and decimals of a foot, never reducing them to yards, rods, or inches. In the same way we measure cloth in yards as to length and inches as to width, but we are never called on to reduce from one to the other. We do not express the diameter of a lead pencil in fractions of a mile, nor the distance from New York to Chicago in yards. Each unit is reserved for its own particular purpose and no confusion results except in the minds of the writers of elementary arithmetics. Our system is thus found to be more simple than we have been brought to believe. We no longer use rods or furlongs to-day, and the need for them is past. Why should we load up our system with such impediments before comparing it with the metric system stripped of such complications. Troy pounds, apothecaries' weight, fluid measure, and so on are no essential parts of the English system. They are used by men who deal with them alone and seldom if ever have occasion to reduce them to the units in common use. In the matter of distances in the metric system there are four units in common use—the kilometer, the meter, the centimeter, and the millimeter. The kilometer is used in measuring long distances in the same way that the mile is with us. The meter is used in the textile trades and in surveying; the centimeter and the millimeter are used in machine work. In a similar way we have among ourselves four units—the mile, the yard, the foot, and the inch. The mile with us for long distances, the yard for textile work, the foot for surveying, and the inch for machine work. It is seldom advisable and almost never necessary for us to reduce from one into the other. We never survey in yards, sell cloth in feet, or design machinery in miles. Each unit is adapted for its own particular purpose and reserved for that exclusively, exactly as in the metric system. The simple ratios between what are practically different units in the metric system are of almost no practical value for the reason that the units are very seldom reduced into one another.

In the matter of weights, we have three units in each system—tons, kilograms, and grams in the metric system; tons, pounds, and grams in the English system, the ounce being a binary division of the

pound. Each weight is reserved for its own specific purpose, one for weighing ore and coal, another for weighing tea and sugar, and the third for medicine and the precious metals. The reduction ratios are simple in every case and are but seldom needed.

The units of volume are more complicated, but may be greatly simplified in the English system without having resort to the metric system. Whatever advantage of simplicity there is with the metric system is very slight in practice, and the argument derived from it in favor of the adoption of that system is almost nil.

Second, in regard to Doctor Stratton's argument that the metric system is a decimal system: The decimal character of that system is not an advantage peculiar to it, since we can and do decimalize our own whenever we find it advisable or convenient. For instance, every surveyor uses a tape 100 feet long, divided into feet and hundredths or thousandths, according to the degree of accuracy called for. In our shops we use micrometers when necessary, which give the dimensions of the piece we wish to measure to the thousandth or ten-thousandth part of an inch. There is no need to resort to the metric system in order to have the advantages of a decimal system, since all these advantages may be had equally well, whenever they are truly advantageous, with our own system. The argument that the system is a decimal system is no argument in favor of its substitution for our own.

In the second place, the decimal character of the metric system is a disadvantage in many cases. We naturally divide things into halves, fourths, eighths, sixteenths, never into tenths, fiftieths, or hundredths. We use these binary divisions of inches or pounds, as the case may be, because we find them most convenient both for estimating and computation. A favorite argument of the advocates of the metric system is that our coinage system is decimal and therefore exceedingly convenient. What may be convenient in the matter of coinage is not necessarily convenient in other matters. A decimal system is a great advantage in addition and subtraction and it is great nuisance in multiplication and division. The computations in bookkeeping most generally consist in adding long columns of figures. Hence the general handiness of a decimal system of coinage. In weights and measures, however, we are most concerned with cases of multiplication and division, and we have found the binary system far preferable to the decimal one. Even in the case of our currency, whenever we find it necessary to use it for multiplication or division we generally resort to binary division. Stocks are quoted not by tenths or hundredths per cent, but by eighths; sugar and cloth are sold not at 6.2 or 4.4 cents per pound or per yard, as the case may be, but at 6¼ or 4½ on account of the greater facility in computation. Thus we naturally, even in our decimal systems of currency, drift into a binary system. It has already been pointed out that the decimal ratios between what are practically different units in the metric system is largely a mythical advantage. In answer to Doctor Stratton's argument that the metric system should be adopted because it is decimal system we would say that our own should be retained, because it may be made a decimal system whenever it is of advantage for us to do so, and it may be kept as a binary system whenever we find it of advantage to do that.

The third argument is that the metric system is an international system. While perhaps a large number of people live in countries in which the metric system is the legal system, it is equally true that a large proportion of these people actually use other systems than the metric. For instance, in the Transactions American Society of Mechanical Engineers, pages 423 to 432, Volume XXIV, may be found a list of over five hundred different nonmetric units which are actually in use in metric countries. The English system, even at the present day, comes nearer being a universal system, if not an international one, than does any other. All of the United Kingdom and its colonies and the United States use it almost exclusively. Germany and Russia use it in part, and it is used both in commerce and manufacture in every other country fully as much as the metric system is used in this. While the English system is not the legal standard of so great a number of people as the metric system, it is used by almost two-thirds of the manufacturing population and nearly three-fourths of the manufacturing wealth of the world, namely, in Great Britain and its colonies, America, and one-half of Germany. For these facts see Transactions already quoted.

The fact that the metric system is international in character is nothing in favor of its adoption unless along with that adoption we should give up our present system. Every reason urged from the viewpoint in favor of the metric system could be urged with tenfold more force for the adoption of a universal language, but we have yet to hear of anyone who would seriously propose such a step. Those countries supposed to use the metric system use a mixed system of units. In many of them, as in Mexico and Central and South America, the mixed system is quite simple in character, consisting only of metric and English units. In others, notably France and Germany, eight or ten different systems exist side by side, and in many industries the English system is dominant. This has been found to result in great loss and disadvantage which are unknown in our own country, because we have only one system.

To quote again from the Transactions of the American Society of Mechanical Engineers, Volume XXIV, on page 403 is found a calculation of the cost of a piece of cloth 1 meter wide and 100 meters long. The operation is described by Mr. Dale in the following manner:

> The raw material is purchased by the English pound. The finished goods are sold by the French meter. The yarn counts are English, while the length and widths of finished goods are metric. The length of the yard is expressed in meters, and its size in pounds per so many yards. From this hodgepodge the weight of the yarn is calculated in grams, which is extended by another arithmetical somersault at a price given in marks per pound, and to cap the climax the total length of the yarn in meters is reduced to English yards and then to skeins of 560 yards each. There is no theory here. It is a common example of German practice at this moment.

As a further example of the system of units actually employed in so-called metric countries, it may be noted that the yarn schedule of the German tariff bill a few years ago, which I believe is still in use, was given in accordance with the English system. The Krupp Steel Works uses the English system at Essen, in Germany, and in many German shops both millimeters and inches are not infrequently used on different portions of the same piece. In Mexico and other Spanish-American countries pipe, steel work, bolts, rolled iron, and so on are almost invariably sold to the English dimensions with respect to

width and thickness and to the metric dimensions with respect to length. A building so many feet long and so many feet wide is on such and such a meter level. A dealer sells you so many meters of 3-inch pipe, or half inch by inch bar iron, or so many kilograms of 3-inch I-beams weighing a given number of pounds to the foot and cut perhaps 4 meters long. Such a hodgepodge as this is the simple, decimal, international system in use in Germany, Mexico, and many other metric countries.

It is of no advantage to substitute one simple system for another equally so. It is of no advantage to substitute one decimal system for another. It is of no advantage to substitute a system which is emphatically not international in character for the one we are thoroughly accustomed to.

There are several objections to the adoption of the metric system in this country, either in whole or in part. In the first place, we would either have to continue with a mixture of the two systems, the metric and the one now in use, or else we would have to turn at once to the metric system, giving up our present system. Of what advantage would it be to us to turn to the metric system if the units were of more inconvenient size, the computation in it practically more difficult, if it would result in great losses by rendering useless a great body of data on engineering and technical subjects and millions of dollars worth of technical literature, and the loss in a large measure in the ability to readily design and construct all kinds of machinery because of the unfamiliarity of the new units?

To take up the first point, the inconvenience of the size of the units: Either the millimeter or the meter are the units commonly used in machine design in continental countries. The meter is by far too large; the millimeter many times too small. The inch, on the other hand, is of such a size that we can do almost all our computations in simple multiples or fractions of it. It is much easier to imagine a certain thing about 10 inches in diameter than one about 250 millimeters in diameter, and the ability to construct any machine or piece of apparatus in the English system is correspondingly greater. Many of the metric units are of convenient size, but the ones that are most used, unhappily, are the ones that are of the most inconvenient size.

In the second place, accurate computation for most purposes is fully as difficult, if not more so, in the metric system as in the English. A statement made by Mr. Henry Hess in the American Machinist for October 16, 1902, says the decimal system is only in part more convenient than the binary system, but not wholly so. It is in fact more uncertain in arithmetical operations than the English system. A certain problem was submitted to seven draftsmen, some of them of more than average attainments and all of them thoroughly familiar with the metric system through having used it almost exclusively in their practice and schooling. (This occurred in Germany.) The correct result was arrived at by only three of the seven men. The problem was at first given to but one man, and only the obviously wrong result led to its being handed over to the others. The difficulty lay in the correct location of the decimal point. With one exception all had the correct numerals, but the men were apparently lost in the mass of decimal figures. The same problem with equivalent values in English units was then handed out. The correct result was arrived at by six out of seven men in an average of two-

thirds of the time taken for its solution in the metric system, showing that the percentage of error was very much less and the time somewhat less with the binary system, notwithstanding the relative unfamiliarity of the men with these units.

I may add, as the result of personal observation through a good many years of engineering work involving both systems of units, that the English system adapts itself far more readily to the design of machinery in engineering constructions than does the metric system. I have in that time been engaged largely in the design of pumping engines dealing with decimals of feet, fractions of inches, and gallons in the same work. While this work involves the greatest possible complication of English units, I have never at any time found it difficult to get correct results, and on the whole the work was rather simpler with the binary divisions of inches than it would have been with decimals. If the additional complication of feet and gallons had not entered into the work the computation would have been far simpler with the binary fractions and a unit of convenient size like the inch than it would have been with units of inconvenient size divided decimally, like the meter or millimeter.

Most of the technical literature available to the English speaking man is in the English system of units. This is the body of information to which all American engineers, almost without exception, refer daily to settle the thousands of problems coming before them. By the immediate adoption of the metric system this body of information is rendered useless at one stroke unless indeed we vastly complicate the amount of figuring we have to do by translating it with a series of reduction tables into the metric system. The layman would be surprised were he to find the enormous value merely of the books in which this work is found and were the adoption of the metric system to work no other hardship it would result in the loss of all value of many millions of dollars worth of such technical literature.

In regard to the men themselves long practice and thorough familiarity has given a high degree of skill in the use of the English units. This skill of thousands of engineers and mechanics is worth an incalculable sum to the United States, and it were far better, we believe, that some act of Providence should blot out of existence all of our machinery and apparatus for making it than that this skill should be lost. The consequences would be at least as grave in the one case as in the other. Andrew Carnegie has made the statement that he would far rather that all his mills should be swallowed by an earthquake than that a few hundred of his best employees should desert him in a body, and I think this is a fair estimate by a practical man of the value of such skill to the American people. If the advocates of the metric system propose its immediate introduction and the suppression of the present system, they practically advocate the almost total destruction of one of the surest foundations of American industrial prosperity.

It is not proposed, however, in the bill at present under consideration to abolish the English system of units except in Government work, the idea being that with the two systems introduced side by side in this country the supposedly better one with Government sanction would be able to drive out the presumably inferior one. Such an idea is not borne out by the actual condition of affairs in so-called metric countries, as Germany and Mexico, as has already been

pointed out. The result would rather be a mixture of the two systems, obliging each man to make himself familiar with both, with resulting deficiency in the skill of the use of either.

In the testimony taken before the committee mention was made by Mr. Fisher, I believe, of the great simplicity which would result from the adoption of the metric system in Government offices. As an example of that simplicity I would say that the probabilities are that when the Government attempted to build some new cruisers or battle ships the proper Department would advertise for 10,000 kilograms of 9-inch channels, weighing 34 pounds to the foot and cut to lengths of 7 meters, 40 millimeters. Perhaps we may vary this by buying sufficient pipe for the ship in inch sizes cut to metric lengths, or when they wished some bolts they would advertise for so many hundred kilograms of three-fourths inch bolts, 10, 12, and 15 centimeters long. The great simplicity of the system becomes at once apparent. Is it the purpose of the bill to compel the Government to use metric-standard pipe and threads, which are seldom used even in so-called metric countries, and which it is at present impossible to buy in the American market, or would they expect our contractors and manufacturers to prepare special lots for them at a specially high price? As a business proposition, in either case, the Littauer bill is not attractive.

Introducing the metric system in this way, so far from making for simplicity would make confusion worse confounded. We must, then, be able at a moment's notice to change from one system to another—to buy sugar, for instance, by the kilogram and sell it by the pound; buy cloth by the meter and sell it by the yard—continually changing, by the use of tables or laborious computation, from one system to the other, with an excellent chance of error each time such a change was made. The result would be that no mean part of our energies were used up in such calculations and in close attention to what manner of unit we were using for the purpose in hand. A half kilogram weight would readily find its way to the pound scale and 10 yards of cloth would often be measured where 10 meters might be what was wanted, thus bringing great confusion even into our private lives. This picture is not fanciful nor overdrawn and certainly far more real than the statement by Doctor Stratton that " for all practical purposes Great Britain and the United States are one," and therefore a system common to them is by no means international.

The second and even more serious result of the adoption of the two systems side by side would be the great confusion in our mechanical standards—for instance, where we now have pipe based on the English system of units we would then have two kinds of pipe of very nearly but not quite the same sizes, based on both systems. As an example of the confusion that would result from this, I might state that six different kinds of tees (a very commonly used pipe fitting) would be needed where only one is now necessary. The same sort of confusion would be produced in all cases where bolts, standard rolled steel shapes, wire, and a dozen other things equally common in the mechanical world are in general use. At present we have certain established standards in these things which are of exceedingly great value to us. They are the result of a long outgrowth and are exactly fitted to our needs. To introduce a second standard alongside of the first

would be to destroy the value of both. It has been mentioned already that six different kinds of tees would be required in every size of pipe fitting. This is only an example of the enormous amount of stock which dealers in all kinds of mechanical goods would be obliged to carry in order to satisfy their customers under the new conditions. Where a man now has $2,000 or $3,000 tied up in such stock he would then be required to carry $10,000 or $20,000 worth. The interest on these sources of loss alone would amount to a formidable annual sum.

If we were able to capitalize all the sources of loss mentioned at some figure and put it before you as the cost of changing our system, even granted that the change could be made complete in fifty years and at the end of that time no vestige of the old English system remained anywhere, I think it would stagger the most hard-headed man to be told that such was the price we were asked to pay in order to adopt a "simple, decimal, international system," whose chief advantage lies in the fact that it is not, when held up to public view, burdened with a host of obsolete units.

EXTRACTS FROM LETTER OF J. H. SOUTHARD TO PROF. JOHN E. SWEET, MARCH 10, 1906.

Something like three-fourths of our imports come into this country invoiced in the metric weights and measures.

Every Department of the General Government is now obliged to use the metric weights and measures quite extensively.

I have consulted many scale manufacturers, who told me that the use of metric appliances for weighing and measuring is considerably on the increase as compared with those used for weighing in any other system.

There is no country in the world having any other than a decimal system where there is not constant agitation in favor of a change to the decimal system. The colonial premiers of Great Britain have time and again resolved in favor of a compulsory metric law. At one time or another bills providing for a change have passed the upper or lower house of Parliament. At a meeting of the representatives of the chambers of commerce of the United Kingdom, held at Toronto two or three years ago, resolutions were passed by an almost unanimous vote recommending the compulsory adoption of a decimal system for both coinage and weights and measures.

The metric system is an international system. I am advised that almost every comparison in weights and measures throughout the world is made with reference to metric standards.

Even our legislation abounds in metric units. We legislate for the Porto Rican and Philippine tariffs in metric terms.

Our standard electrical units are all based on the metric system.

Mr. Herbert E. Davidson, president of the Library Bureau, of Boston, testified that the concern with which he is connected employs more than 2,500 men, all of whom work in the metric system in making furniture, and that he uses the metric system of units because it is more convenient and expeditious to do so.

Admitting all that Mr. Southard says above, it only shows that the metric system is already widely introduced into our country, and that some people find it an advantage to use it. But all this does not make it therefore advisable to enforce the use of the metric system on the people who do not want to use it. The people who do not want to use the metric system are not only some manufacturers and some mechanical engineers, as Mr. Southard says, but they are millions of people who are actually using 2-foot rules and inch scales. Because Mr. Carnegie, who probably never used a machinist's inch scale in his life, and Mr. Thompson and Mr. Westinghouse, who do none of the practical work of their own shops, but only the inventing for them, are in favor of the metric system, it is no reason

why the manufacturers of the country, who have their money invested in tools, patterns, and drawings based on the English system, and the mechanics of the country, who have been brought up on the English system, should be compelled to drop the English inch and use the French millimeter.

They can not be compelled to do it, and they will not do it of their own free will.

Mr. Southard in this letter to Professor Sweet says further:

> Concerning the manufacture of the Wilcox & Gibbs sewing machine by Brown & Sharpe, of Providence, R. I., they could continue to manufacture the machine after as well as before (the introduction of the metric system), and if the Government desired to purchase a Wilcox & Gibbs sewing machine they would purchase it by number and in the same way they would purchase it today. There would be nothing to cause a change in the machine, and they could not make it with other tools. It would be the same with an engine, machine, tools, or any supplies that the Government might wish to purchase. Any standard machine that has been built for twenty-five years could be built for twenty-five years more, so far as I can see, without changing a drawing, pattern, or tool, or anything entering into the construction of the machine. The statement that large expenses and inconveniences would result arises from this assumption that manufacturers will all at once abandon their present standards, involving plans, drawings, tools, etc., in order to make the change to even metric sizes. You will agree with me that this would not happen.

We will certainly agree that this would not happen. Iron and steel makers would still turn their rolls so as to produce round and flat bars in inch sizes. These sizes would continue to be cut in the machine shops to other sizes based on the inch and its binary subdivisions. Screw threads would be cut on bars with so many threads to the linear inch and pipe flanges would be drilled for so many 1-inch bolts in a circle of so many inches diameter; so if the metric system was introduced, the English system would persist alongside of it. The people would not give it up voluntarily and the Government has no power to force them to give it up. Therefore the only thing that the introduction of the metric system can do is to establish the confusion of two systems existing side by side, compelling every educated person who reads any literature concerning weights and measures either to acquire the extraordinary power of being able to think in two systems or else having to spend time to make a translation from one system to the other. The time of our children in the schools will be wasted by compelling them not only to work in both systems, but to work in problems involving the translation from one to the other. What a vast amount of time would be saved to our school children if the metric system could be wiped out of our arithmetics and if all the obsolete terms of the English system were also dropped. If this were done the English system would be even more simple than the metric system.

Mr. Southard says further:

> Manufacturing is in spots. Commerce is everywhere and dominating. A decimal system will become universal commercially, and the system used commercially everywhere will dominate every other.

Let us analyze this statement of Mr. Southard's. In what manner does commerce dominate manufacturing? Can commerce exist without manufacturing or can it compel men to manufacture? The fact is that the manufacturer himself is the commercial man. He makes goods and he employs men to find a market for them. Mr. Southard says:

> A decimal system will become universal commercially.

Well, suppose it does. Suppose every inch bar is listed commercially as 25.4 millimeters. Is that going to prevent the manufacturer from continuing to make bars of 1 inch diameter, or turning his rolls to that size, or dominate him in any way except in the way he shall make out his bills? When the Government orders a No. 1 Wilcox & Gibbs sewing machine—that is commerce. How can that commerce dominate the Brown & Sharpe Company in regard to the manufacture of that sewing machine, and compel them to use the metric system in its manufacture? No; manufacturing is not dominated by commerce. The manufacturers are the commercial people, and they may choose to use the metric system in commercial transactions and the English system in manufacture.

And how is this bill which is intended to compel all the Government Departments to use the metric system in their transactions going to change the situation in the slightest degree or in any way tend to cause the manufacturers and the mechanics of the country to adopt the metric system? In fact, this homeopathic and sugar-coated bill is carefully drawn so that it can be said that it does not compel anybody outside of the Government Departments to do anything.

It is not a bill for the compulsory adoption of the metric system by the people of the United States. It is not even a bill which will compel the changing of a drawing or a tool entering into the construction of a machine. It is not a bill compelling manufacturers to abandon their present standards in plans, drawings, tools, etc., in order to make the change to even metric sizes.

Then what is the use of this homeopathic sugar-coated bill? It is not a bill for the benefit of the Departments. It is not a bill for lessening the labor or the expenditure or advancing the material interest in any way of anybody. It is simply an experiment, "Trying it on the dog," as Mr. Southard said in his discussion before the American Society of Mechanical Engineers two years ago, in the hope that it may educate the people in the use of the metric system. It is a vain hope. The metric advocates have been hoping this for forty years. They have had American metric bureaus and American metrological societies. They have been making attempts to pass bills in favor of the metric system ever since 1866, when one was passed making the use of it legal. They got the people pretty well educated in the metric system, but the people don't want it and they can not be compelled to use it. Why should the Government of the United States go to any more trouble to educate the people in the use of the metric system when the people are not asking for this education?

Mr. Southard further says:

> We have received at one time or another resolutions passed by associations of teachers almost without number. Only to-day we have received a long petition containing the names of a very large majority of the faculty of Washington State University. We have also received a petition signed by several of the professors of Wesleyan University. Also resolutions passed by the Parents' Auxiliary Association of Public School 33, Borough of the Bronx, New York, and resolutions passed by the Massachusetts Agricultural College of Amherst, Mass., all of them favoring the adoption of the metric system.

No doubt the activity of the American Metrological Society could have the result of getting petitions from all over the country, from every kind of association of people who do not in their daily work actually have to use the English inch, all of them favoring the adop-

tion of the metric system. What do all these people mean by the adoption of the system? Do they mean the abandonment of the English system by the people who are actually using it, or do they merely want this bill to be passed in the hope of educating the people so that they should voluntarily use it some day in the future? Suppose these petitions came in in such overwhelming numbers that the committee reported the bill favorably to Congress and both Houses passed the bill and the President signed it. How much nearer would we be to the adoption of the metric system and to the abandonment of the English inch when the machine builders of the country and the makers of measuring scales and other instruments based on the English inch are turning out their products by the thousands, every one of which tends to educate the people in the continued use of the English inch—when every mechanical text-book and reference book in the English language for the use of English-speaking people is full of tables, formulæ, and rules based on the English system? Is not the education which naturally goes on in the use of the English inch by these processes a hundred times as great as any education in the metric system which can be made by the Government if it passes this homeopathic, sugar-coated bill?

WILLIAM KENT.

SYRACUSE, N. Y., *April 4, 1906.*

Dean WILLIAM KENT,
The New Willard, Washington, D. C.

DEAR SIR: Please represent us in opposition to a favorable recommendation of the Littauer bill, or metric system of weights and measures. We have in our employ 200 people, and are emphatically opposed to the adoption of this system.

Thanking you in advance for your kindness in the matter, we are,
Yours, very truly,

CROUSE-HINDS COMPANY.

ARGUMENT ON METRIC-SYSTEM BILL BY WILLIAM KENT, DEAN OF COLLEGE OF APPLIED SCIENCE, SYRACUSE UNIVERSITY.

Mr. KENT. My arguments will be based generally on the statements made by Mr. F. W. Stratton, Director of the Bureau of Standards, in his argument before the committee on March 1 in favor of the bill.

Mr. Stratton says, "There is a difference between the scientific side and the practical side of this question." If scientific people have adopted the metric system, it is for precisely the same reasons that practical people will adopt it in the end.

Here Mr. Stratton seems to hold that there are two opposite sides to this question, the scientific side and the practical side, and that there are two different kinds of people, scientific people and practical people; yet later in his argument he says, "The man who makes the distinction between the scientific and the practical makes a distinction which does not exist. It is a great mistake to draw a line between the scientific and the practical." His first statement is in harmony with a great deal that has been written by the metric advocates to the effect that the metric system is universally used by scientific men, that it is the only scientific system, and that men who

oppose its adoption by the English-speaking nations are only practical and not scientific. His later statement, which it is difficult to reconcile with the first, is more in consonance with the facts. It is pure assumption on the part of certain workers and writers in pure science that they are the only real scientific men, and that the leaders in applied science, who are doing the practical work of the world—the engineers—are not scientific men. The industrial arts, which are increasing the wealth of the world, are based on the sciences of mathematics, geology, chemistry, physics, and mechanics. The advances in metallurgy and the mechanic arts are calling for the highest class of scientific work in chemical analysis, in high-temperature measurements, in microscopy, in micro-photography, and in micrometric measurements of length. The captains of industry are calling for the services of an increased number of scientific men each year. The demand creates the supply, and the scientific colleges, the colleges of engineering, are turning out scientifically trained men by the thousands. In this country and in England the young scientists are trained in the chemical and physical laboratories to use the metric system; in the engineering laboratories, drawing rooms, and class rooms they use the English system. They are both scientific and practical in every sense of the words, and they will agree with Mr. Stratton in his later statement that "It is a great mistake to draw a line between the scientific and the practical."

Mr. Stratton says that the advantages of the metric system are its simplicity, its decimal character, and its international character. Let us admit it. We claim that the English system has the same advantages. Consider first the relative simplicity of the two systems.

The metric measures of length are based on the standard meter, a bar of metal kept in Paris. The English measures are based on the standard yard, a bar of metal kept in London. The metric measures of weight are based on the standard kilogram, and the English measures of weight are based on the standard pound. Metric measures of area and volume are based on the meter; English measures on the yard.

In the metric system the measures of length and weight are tied to each other in such a way that a cubic meter of distilled water at a certain temperature weighs 1,000 kilograms. In the English system a cubic foot of water at a certain temperature weighs 62.425 pounds; but in both systems corrections have to be made for temperature in all practical cases, requiring references to tables for temperatures of the weight of water at different temperatures, so that the superiority of the metric system to the English in the use of the figure 1,000 instead of 62.425 is more apparent than real. In calculations of the relative weight and volume of other things than water reference must be made to tables; thus in the French system a table of specific gravity will show that a cubic meter of cast iron weighs 7,218 kilograms, and in the English system a cubic foot of cast iron weighs 450 pounds.

In regard to the subdivisions and multiples of the basic units and in regard to their names, the argument as to simplicity seems rather in favor of the English system. The prefixes milli, centi, deci, deca, hecto, kilo, and myria are more confusing, to an English-speaking person at least, than the definite names miles, yards, feet, and inches. Mr. Stratton says of the metric system, "All it is necessary to remember is the unit we are using continually. You could express the

fraction of a kilogram in grams if you choose, but more than likely you would express it in fractions of the kilogram." So in the English system the astronomer and the railroad man could use miles for long distances, the surveyor and the builder feet, and the machinist in the shop inches and fractions. No one would need to remember any unit except those he needed to use. The designer of machinery in the United States uses only feet and inches, but the designer in France uses meters, centimeters, and millimeters, often all three on the same drawing. In both systems special names are given to units used for certain purposes, such as the liter instead of the cubic decimeter in France for liquids and the gallon instead of its equivalent, 231 cubic inches. The English system can be improved by dropping the gallon, as it has already dropped other unnecessary units, and using instead the cubic foot, or if a smaller unit is needed a new gallon of 216 cubic inches, the cube of 6 inches or one-eighth of a cubic foot. So the pint would be the eighth of a gallon or 3 inches cubed.

The next argument of Mr. Stratton in favor of the French system is its decimal character. In this it has no superiority over the English system, for the latter also can be and is used decimally. Surveyors use feet and its subdivisions into thousandths; machinists use inches and thousandths. Railroad men use miles and hundredths. The use of the micrometer caliper with the inch divided into thousandths and capable of being read to ten-thousandths is universal in American machine shops. Limit gauges are also in general use for inspecting bars of iron, in which one or more thousandths of an inch is added to or subtracted from the standard. There is no reason why any other unit can not be divided decimally whenever there is any convenience to be gained by so doing. The common 2-foot rule is often divided into sixteenths of an inch on one side and into tenths of an inch on the other.

The great superiority of the English system for common everyday use is that it is capable of being subdivided by two, as far as convenience requires; thus our steel scales used in machine shops having eight corners, have one corner divided into eighths, a second into sixteenths, a third into thirty-seconds, and a fourth into sixty-fourths, while the other four corners are divided into tenths, twentieths, fiftieths, and hundredths. Mr. Stratton admits that this can not be done in the metric system. He says:

> When you go beyond halves and quarters, as, for instance, eighths and sixteenths and thirty-seconds, the complication becomes too great. * * * It is not advisable to carry out the binary subdivision beyond halves and quarters.

The reason is easily seen. If a decimeter is a convenient unit of length, $\frac{1}{2}$ decimeter is 5 centimeters, $\frac{1}{4}$ decimeter is 2.5 centimeters, $\frac{1}{8}$ is 1.25 centimeters, $\frac{1}{16}$ is 0.625, and $\frac{1}{32}$ is 0.3125 centimeters. That the binary system of subdivision is the most natural is shown by the French people themselves, who, as Mr. Stratton says, use the half and quarter kilogram in common ordinary transactions in preference to their equivalents, 5 dekagrams and 25 centigrams, which are inconvenient.

The English system is just as truly a decimal system as the metric system. Each of its units can be subdivided into tenths, hundredths, and thousandths by anyone who wishes. Most of the tables of reference used in the machine shop, such as dimensions of pipes, flanges,

screw threads, etc., have the figures expressed in inches and thousandths. Each user of the system chooses the unit that suits him best—the mile, the foot, the inch (the yard is scarcely ever used in practice outside of the dry-goods store), and he never thinks of the "confusion and waste of time and energy that result in translating from one of these dimensions to the other," which Mr. Stratton so deplores, because by using a single unit he does not have to translate from one to the other. In the English system the astronomer who measures the distance to the stars uses miles only. The railroad builder, who measures distance on the face of the earth, uses miles and their decimal fractions. If he ever wishes to convert a fraction of a mile into feet, it is so easily done that it never causes confusion, and the time and energy used in the translation is such an insignificant thing that no one notices it. The man in the shops uses inches, subdivided either into thousandths or into binary divisions, as may be most convenient, and while he cannot translate his measures into the measure of distance to the heavenly bodies—namely, the mile—by simply shifting the decimal point, as Mr. Stratton says can be done in the metric system, it is no inconvenience to him, for never in all his life is he called on to make such a translation, any more than the Frenchman in the shop is called on to shift his decimal point for a similar translation. The French workman or engineer is no more concerned in the fact that the diameter of a 25.4-millimeter bolt may be expressed in the measure used by the astronomer by simply moving the decimal point six places, thus—0.0000254 kilometer—than is the American in knowing that the diameter of the same 1-inch bolt is 0.00001576 mile.

The third argument of Mr. Stratton in favor of the metric system is that it is international. So is the English system international. It is part of the English language, and that language is more nearly an international language than any other. A few hundred years ago scientific men wrote in Latin, as that was considered the international scientific language. Newton's Principia was written in Latin. Every educated engineer the world over studies the English language and is familiar with its system of weights and measures. In ordering goods from England or America he can order them in either the metric or the English system with equal facility. The simplicity of the English system appeals to the foreign dealer in that every factory product of wood or of metal made in Great Britain or America may be ordered by the use of three units only, feet, inches, or pounds; feet for lengths exceeding 36 inches, inches for lengths under 36 inches, and generally for thickness and diameter, and pounds for all weights whatever. The only conversion table really needed to translate from French to English measures is one of only three items: 1 meter = 3.2808 feet; 1 millimeter = 0.03937 inch, and 1 kilogram = 2.2046 pounds.

The fact that the English system is international is shown by the fact that it is in actual use to some extent in every country in the world. Mr. Dale's book on The Metric Failure in the Textile Industry showed that it is used everywhere in that industry, even in France. Mr. Stratton speaks of the manufacture of steam fittings: "When you send your fittings to France or Germany you don't find it necessary to change the tools in manufacturing?" and he said

"No." So American standard steam fittings and screw threads are used in Germany, and they are listed and known there by their sizes, as so many inches diameter and so many threads per inch of length.

Mr. Stratton says:

> We have in the metric system the only decimal system that has been proposed. * * * It is the only decimal system that is at all international in character. * * * Can we decimalize our system, and if we can, can we force it upon all the rest of the world?

The facts are that the metric system is not the only decimal system that has been proposed, for it has not only been proposed over and over again to use the English system decimally, but it is actually so used. Goods made on the English system used decimally, such as wrought iron and steel pipe and pipe fittings, are listed and described in English decimal dimensions, and sold and used in all parts of the world. We do not need to "force the system on the world." It is being used by the nations of the world voluntarily. Here is a sample of the international use of the American standard system. The American 4-inch boiler tube is a standard article of commerce. It is needed to replace worn-out tubes in old boilers, and new boilers with such tubes are being shipped from the United States all over the world. A foreign engineer having to do with such a boiler would be interested to learn all he could about the 4-inch tube. He would find the first column of figures in the following table in all American lists:

Outside diameter	4.000 in.	metric	0.1016 meter	0.1000 meter
Inside diameter	3.732 in.		.0948 meter	.0932 meter
Thickness	.134 in.		.0034 meter	.0034 meter
Internal circumference	11.724 in.		.2977 meter	.3 meter
External circumference	12.566 in.		.3192 meter	.3142 meter
Internal area	10.939 sq. in.		70.578 sq. cm.	
	.0760 sq. ft.		.706 sq. dm.	
External area	12.566 sq. in.		81.078 sq. cm.	
	.0873 sq. ft.		.811 sq. dm.	
Length of tube per sq. ft. of inside surface	1.024 ft.		.3110 meter	
Length of tube per sq. ft. of outside surface	.955 ft.		.2911 meter	
Weight per lineal foot	5.47 lbs.		2.481 kg.	

He might construct for himself a table of the same values in the metric system as in the second column of figures, but in calculating boiler heating surface, flue area, weights, etc., he would probably find it more convenient to do all his figuring in the English system, using the figures of the American list, and then, if he wished, to translate his final results into the metric system. The second table would, however, be in a mongrel system in the last three lines, having both English and metric measures. There would have to be added three additional lines, as follows:

Length of tube per sq. dm. of inside surface	0.1416 meter
Length of tube per sq. dm. of outside surface	.1233 meter
Weight of tube per meter length	8.139 kg.

So the foreign engineer, having to make calculations in regard to an American boiler, would use the English system of weights and measures, simply because the tube is 4.000 inches outside diameter and all the figures concerning it are printed in the English system only. A foreign boiler repair shop in order to repair the American boilers has to have drills, reamers, and expanding tools of the exact size nec-

essary to cut the holes in the headers or tube sheets and for expanding the tubes. In like manner every foreign machine shop which uses a machine in which there are United States standard bolts has to use the American tables of screw threads in case any such bolts have to be replaced or duplicated. So foreign engineers and mechanics all over the world are for their own convenience finding it necessary to learn the English system and to become acquainted with English and American standards. In other words, the English system is an international system in machine and boiler shops wherever American products are used. We are not forcing the system on the world; it is forcing itself, just as the English language is.

The metric advocates pride themselves on the fact that a greater number of nations have adopted the metric system as the legal standard than have adopted the English system. The question which system is the most extensively used is not to be settled in finding which has the longest list of nations apparently in favor of one or the other according to the laws of these nations, nor even by summing up the population of these nations, but rather by finding out which system is actually used by the greatest number of people. The people who use measures of length to the greatest extent are the mechanics, the manufacturing people, those who use iron and other metals, wood and stone finished to dimensions, and not those who are chiefly farmers and herdsmen. No exact statistics are obtainable, but it will not be denied that the manufactured products involving the use of the foot and inch and requiring the greatest use of measures of length in their production are more numerous as to number of pieces and greater in quantity in England, Canada, and the United States than in all the rest of the world put together. More people actually use the English measures of length in their daily occupations than use the metric measures.

The manufacture of iron is generally considered to be the index of the greatness of a nation in the industrial arts. The following is the latest report of the pig-iron production of the world:

World's pig-iron production, 1905.

	Gross tons.
United States	22,992,380
Germany	10,813,983
Great Britain	9,592,737
Belgium	1,329,109
Sweden	518,967
Canada	468,003
Other countries	7,825,662

Great Britain, Canada, and the United States taken together produce 61.8 of the total pig iron of the world, leaving only 38.2 per cent for all of the rest of the world put together.

The great bulk of the pig iron is either cast into shapes or converted into wrought iron or steel in the country where it is made, and is not exported in the raw state. It gives employment in each country in which it is made to mechanics of all kinds, and the number of these mechanics in each country is no doubt not far from being proportional to the pig-iron tonnage. If this is so, then practically five-eighths of all the mechanics of the world use the English foot, inch, and pound, and only three-eighths use all other systems.

I have thus traversed all of Mr. Stratton's arguments in favor of the metric system. Admitting his three points for the metric system, that it is simple, decimal, and international, I claim the same things for the English system—that it is simple, decimal, as well as binary, and international. It is scientific, convenient, suited to the habits of the people, "irrevocably tied to the past," present and future by its incorporation in permanent standard gauges, tools, and drawings, and literature, an irremovable part of the English language; and it can no more possibly be got rid of, either by the further education of the people in the metric system, or by acts of Congress or of Parliament, than can the English language.

Now, as to this bill. What is it for? Mr. Stratton says:

> It is not my understanding that if the Government adopts the metric system that it will do any thing more than buy and sell by the meter or by the kilogram or by the liter. Plows are listed 1, 2, 3, 4, and the Government buys 1, 2, 3, 4, as it likes. We buy any machine as the machine itself.

The Navy Department wants 1,000 4-inch tubes shipped to a navy-yard. It wants them of one of the standard lengths, say 18 feet. It wants the tubes and doesn't care whether the bill says 4 inches diameter or 15.75 centimeters, or 18 feet long, or 5.806 meters, or whether the bill is for 18,000 feet of pipe, at so many cents per foot, or so many pounds at so many cents per pound, or 5806 meters of pipe at so many cents per meter, or so many kilograms at so many cents per kilogram. The inspector on receiving the pipe will caliper them with a 4-inch limit gauge for outside dimension, and with another limit gauge for thickness, and will use an ordinary steel tape graduated in feet and inches to see if they are of the right length. If the bill is made out in the metric system the inspector will have to make an arithmetical calculation to determine whether the metric figures correspond to his measurements, and his calculation may afterwards be checked by an auditor. So the only effect of the bill now before this committee, if it passes Congress, will be to inflict upon some one or more men in the case of each Government purchase, the extra duty of translating English actual dimensions into the approximate metric dimensions, carried out to as many decimal places as may be necessary to verify the bill to the last cent of the amount. So what good will the bill be to any department of the Government? It merely adds some arithmetical work to the auditing of accounts, with the consequent trouble, delay, and liability to error, and puts the seller of the goods to the same trouble.

According to Mr. Stratton's understanding of the bill it means only that the Government shall buy and sell by the metric system, and that the word "transactions" applies only to contracts and bills of purchase and sale, and not to the work done by the Government in its own shops or the shops in which goods for the Government use are manufactured; it does not refer to designs, drawings, bolts, screw threads, beams, plates, or other parts which enter into construction. In the words of Mr. Stratton, it is an experiment "which it might cost the Government something to try." "If it doesn't work in the end we can abandon it any time."

Mr. Stratton further says:

> I do not believe the time will ever come in this country when a manufacturer can not use whatever system of weights and measures he desires. I do not see that a manufacturer would be prohibited from manufacturing a machine in the Spanish vanas if he chose.

Thus Mr. Stratton, the leader of the metric advocates, abandons the attempts which the metric advocates in general have been working for the past forty years, to get Congress to pass a bill making the metric system compulsory. All he asks now is to get this little bill passed, a little experiment which can be abandoned any time, to have the Departments of the Government make transactions merely of purchase and sale in the metric system, involving no trouble to anybody except a few people who will have to do some extra arithmetical figuring.

The bill relates merely to the Government and those who do business of purchase or sale with it. Is it to be any benefit to the Government, to the taxpayers who support the Government, or to those who have the business with the Government? No such benefit is apparent. It will not increase the revenue or decrease the expenditures of the Government or of anybody. Mr. Stratton says he has no financial interest in the bill and it does not appear that anybody else has. There is no question of principle or of morals in it, no reason under the sun why the bill should be passed except the one given by Mr. Stratton in the words " We hope to educate the people in this manner."

The metric advocates have been hoping to educate the people in this manner, by having Congress pass bills in favor of the metric system, for the last eighty-five years, ever since 1821, when John Quincy Adams made his famous report. They have succeeded to a large extent in their educational campaign. In 1866 they got a bill passed making the metric system legal, and they had the Government present to each State a full set of metric standard weights and measures. They have converted many newspaper editors into agitators for the system. They have had resolutions in its favor passed in State legislatures, in scientific and commercial conventions. They have had the system introduced in every public and private school and incorporated in every common school arithmetic. Every boy and girl who has been in the grammar school grades at any time since 1866 has been made familiar with the metric system and compelled to work with it. Every high school text-book on chemistry and physics published in the last twenty years at least contains the metric system and excludes the English system. The ranks of the metric advocates have been reenforced by millions of emigrants who were brought up on the metric system in their own countries. It can not be said that the people of the United States have not had a pretty thorough education in the metric system.

The attempt to educate the people in the metric system by means of an act of Congress has been especially vigorous the last ten years. On March 16, 1896, the Committee on Coinage, Weights, and Measures favorably reported to the House a bill providing for the compulsory use of the metric system by the Government and by the people. It provided:

1. That from and after the 1st day of July, 1898, all the Departments of the Government of the United States in the transaction of all business requiring the use of weight and measurement, except in compiling the survey of the public lands, shall employ and use only the weights and measures of the metric system.

2. That from and after the 1st day of January, 1901, the metric system of weights and measures shall be the only legal system of weights and measures recognized by the United States.

Since 1896 bills in favor of the metric system have been introduced into Congres every year or two, and the Committee on Coinage, Weights, and Measures have considered them.

The result of the agitation of the last ten years has been to demonstrate that the Government has no power to compel the use of the metric system by the people, and the metric advocates themselves now recognize this fact in their abandonment of the attempt to make the use of the system compulsory except in the Government Departments. The present bill is the mildest that has ever been introduced.

The bill favorably reported in 1896 provided that from and after June 1, 1901, "the metric system of weights and measures shall be the only legal system of weights and measures recognized by the United States."

The bill introduced in 1902 (H. R. 123) said, "The metric system shall be the legal standard of weights and measures of and in the United States."

Note the omission of the word "only" from the bill of 1902.

And now the campaign of education by the metric advocates has dwindled down to this last little bill, not to make the metric system compulsory, but only to educate the people by the method of imposing a little extra work on the clerks of the Departments by forcing them to translate English weights and measures into metric on each order for goods and on each bill of purchase and sale of goods by the Departments.

And during all these campaigns of education and attempted legislation, what have the opponents of the metric system been doing? Until the last three years practically nothing. They have been unorganized. They have depended on the good sense of Congress not to inflict such an intolerable burden on the people as the compulsory enactment of a metric bill would be. Here and there an individual would make an appeal to his Member of Congress to resist the passage of such a bill, or would write a paper on the subject for some technical society. In 1895, Herbert Spencer wrote some letters against the system to the London Times (Popular Science Monthly, June, 1896). In 1896 Mr. George W. Colles presented a paper to the American Society of Mechanical Engineers, Transactions, Volume XVIII. In 1902 Mr. F. A. Halsey presented a paper to the same society. In that paper he called attention to the fact that there was actual danger that a compulsory metric bill might pass Congress unless an active opposition was made to it, and then for the first time the opponents of the system woke up to the danger. As the result of that committee a bipartisan committee of four, two in favor of the system and two against it, was appoined to bring in a report presenting the arguments both for and against the system. This report is printed in Volume XXIV of the Transactions of the Society. The report in pamphlet form was distributed to the members, and a letter ballot was ordered, to get the opinion of the members for and against the system. By some mistake the little circular containing the ballot was inserted between the pages of the pamphlet, so that many of the members on taking the pamphlet from its wrapper laid it aside or put it in the wastebasket without ever seeing the

ballot, so that only 514 out of the 2,500 members voted.

Afterwards Mr. Halsey and Mr. S. S. Dale published their joint book on The Metric Fallacy and the Metric Failure in the Textile Industry, which should be procured by everyone interested in studying the subject.

Practically all of the available literature against the metric system, accessible in most of the larger public libraries, is contained in the papers and the report referred to in the Transactions of the American Society of Mechanical Engineers and a paper by Coleman Sellers in Volume I of the same Transactions and in Halsey and Dale's book. Accessible in a few libraries also are the report of John Quincy Adams of 1821, and the report of the Committee on Coinage, Weights, and Measures, Forty-sixth Congress, first session (Report No. 14, Government Printing Office, 1879). Both of these reports contain arguments both for and against the system.

The attention of the present Committee on Coinage, Weights, and Measures is especially urged to the last-named report. On page 67 there is a resolution of the House November 6, 1877, which reads as follows:

> That the heads of the Executive Departments of the Government be, and they are hereby, requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures * * * and that they are also requested to state what objections there are, if any, to making the metrical system obligatory in all transactions between individuals.

The report contains the answers made in accordance with this resolution by the heads of departments and many of their subordinates. They include statements and arguments against the metric system, or against its compulsory enforcement on the people of the United States by the following:

William M. Evarts, Secretary of State.
R. W. Thompson, Secretary of the Navy.
David M. Key, Postmaster-General.
R. B. Macy, Inspector-General of the Army.
M. C. Meigs, Quartermaster-General, U. S. Army.
J. K. Barnes, Surgeon-General, U. S. Army.
R. Macfeely, Commissary-General of Subsistence.
A. A. Humphreys, Brigadier-General and Chief of Engineers.
John Sherman, Secretary of the Treasury.
J. A. Williamson, Commissioner of the General Land Office.
Ellis Spear, Commissioner of Patents.
John Eaton, Commissioner of Education.
C. P. Patterson, Superintendent of the Coast Survey.
J. E. Hilgard, Assistant Superintendent Coast Survey and Inspector of U. S. Standard Weights and Measures.

The answers by these eminent Government officials made nearly thirty years ago are interesting reading to-day, and many of them are directly applicable to the bill now before Congress. It might be well for the present committee to get answers from the heads of Departments as to what would be the result on their several Departments of the passage of this bill.

It is to be hoped that the bill now before the committee will not be allowed to die in the committee, as has been the fate of previous bills, but that a strong adverse report on it will be made, pointing out that the day has long passed for the adoption of the metric sys-

tem by the people of the United States; that it is impossible that it can ever wipe out the English system in this country, and that it is highly undesirable that the Government shall adopt a system of weights and measures that are not in harmony with those used by the people.

The only apparent reason for the passage of this bill is that it is an experiment that ought to be undertaken by the Government for the education of the people in the metric system. As well might the Government experiment on the education of the people in the French language by causing all Government correspondence to be carried on in that language, or in spelling reform in like manner, or in tariff reform, or in woman's suffrage, single tax, or prohibition, by having them all tried experimentally in the District of Columbia. The American people are intelligent enough and educated enough in the metric system to adopt it themselves whenever it is found convenient, as they have adopted it in chemical laboratories and in some other places. It is well now for the Government to let the metric system alone and refer it back to the States or to the people.

APPENDIX.

THE SIMPLICITY OF THE ENGLISH AS COMPARED WITH THE METRIC SYSTEM.

1 inch	=	25.4	millimeters,	reciprocal =	.....	0.03937
		2.54	centimeters,	"	.....	0.3937
1 foot	=	304.8	millimeters,	"	.....	0.00328083
		30.48	centimeters,	"	.....	0.0328083
		3.048	decimeters,	"	.....	0.328083
		0.3048	meter,	"	.....	3.28083
1 yard	=	914.40	millimeters,	"	.....	0.0010936
		91.44	centimeters,	"	.....	0.010936
		9.144	decimeters,	"	.....	0.10436
		0.9144	meter,	"	.....	1.0936
1 mile	=	1,609.351	meters,	"	.....	0.00062137
		1.60935	kilometers,	"	.....	0.62137
1 square mile	=	645.2	square millimeters,	"	.....	0.00155
		6.452	square centimeters,	"	.....	0.1550
		0.06452	square decimeter,	"	.....	15.5
1 square foot	=	929	square centimeters,	"	.....	0.001764
		9.290	square decimeters,	"	.....	0.10764
		0.0929	square meter,	"	.....	10.764
1 square yard	=	83.6	square decimeters,	"	.....	0.01196
		0.836	square meter,	"	.....	1.196
1 acre	=	2.471	hectares,	"	.....	0.4047
1 square mile	=	1,581.44	hectares,	"	.....	0.0006323
		2.59	square kilometers,	"	.....	0.3861
1 cubic inch	=	16,387	cubic millimeters,	"	.....	0.000061
		16.387	cubic centimeters,	"	.....	0.061023
		0.016387	cubic decimeter,	"	.....	61.023
1 cubic foot	=	28.32	cubic decimeters,	"	.....	0.035314
		0.02832	cubic meter,	"	.....	35.314
1 cubic yard	=	1.308	cubic meters,	"	.....	0.0765
1 pound	=	0.45359	kilogram,	"	.....	2.20462
1 ton	=	0.90718	metric ton,	"	.....	1.10231

Here are 14 English dimensions, which include practically the whole of the English system of weights and measures after it has had some of the unnecessary terms dropped from it. The acre might be dropped if it were not that it is recorded in deeds of land and is the customary unit for buying and

selling land outside of cities. The cubic inch, cubic foot, and cubic yard and other decimal subdivisions could be used for measuring liquids and grain just as well as bushels and gallons, if we desired to make the change.

Every one of these 14 units is part of the language of every English-speaking person from his early childhood. He thinks in these units, and this habit of thinking he will never lose no matter how much he familiarizes himself with the metric system. This English system also can never be lost from the English language and literature or from the English workshops. It may be possible to adopt the metric system in all Government establishments and compel all the Departments to have the drawings, patterns, tools, templets, screw threads, etc., made entirely on the metric system, and that all work done in the shops of the Government shall be done by mechanics who carry in their pocket a metric rule. It might force on people who do business with the Government the use of the metric system, but all of this would not extinguish the English system. The two systems would remain side by side, causing intolerable confusion. It would be necessary for people who had anything to do with weights and measures to continually carry around with them a table like the one above given for constant reference, for it would be impossible for anyone to memorize it. In translating a dimension given in feet the user of this table would first have to consider whether the translated dimension should be given in millimeters, centimeters, decimeters, or in meters; and if he should multiply one of the four corresponding figures given in the table or should divide by one of the figures given in the table of reciprocals, he would have to watch the position of the decimal point with great care to avoid making a mistake.

The English system contains four measures of length—inch, foot, yard, mile—of which the mile is only used for long distances on land, the yard only for the length of cloth, and the foot and inch for every other measurement. Against this we have the five metric measures, millimeter, centimeter, decimeter, meter, and kilometer. The kilometer is used, like the mile, only for measuring long distances, but the other four units are often used without discrimination. Thus some drawings of machinery will have all the dimensions expressed in millimeters, often up to thousandths of a millimeter, other will have drawings made in meters and decimals of a meter. So, likewise, in measures of surface we have five English measures—square inch, square foot, square yard, acre, and square mile, the last two being used only for measurements of land. The French have, instead of the three English units, square inch, square foot, and mile, the four units, square millimeter, square centimeter, square decimeter, and square meter. For land they have the hectare and square kilometer, corresponding to our acre and square mile. The English system for volume has only the cubic inch, cubic foot, and cubic yard. The French system has four measures—cubic millimeter, cubic centimeter, cubic decimeter, and cubic meter. For weights the English system may be reduced to tons, pounds, and decimals of a pound, corresponding to the French tons and kilograms.

In no single instance does it appear that the French system has any advantage over the English in regard to simplicity. On the contrary, with the 14 units of the English system there are 18 units in the French. The French units have nothing to recommend them in size or in name. Will anyone who is accustomed to use in his daily employment the inch and the foot, the square foot or the cubic foot, consider what it would mean to him if he was compelled to do his work in the French system, and he will see how impossible it is for any amount of education of the people or any amount of legislation to compel the English-speaking people to give up the English foot and inch. No English-speaking country has ever given up these measures, and it is reasonable to believe that no such country ever will.

STATEMENT OF MR. GEORGE M. BOND, MECHANICAL ENGINEER, HARTFORD, CONN.

Mr. BOND. Mr. Chairman and gentlemen of the committee, I would state that I am a mechanical engineer, my education starting from the high school, followed by seven years in the machine shop, building woodworking machinery, engines, and general machinery, followed by a course of four years in engineering at the Stevens Institute of Technology, being graduated in 1880 as a mechanical engineer.

My work the last year in college brought me in connection with Prof. William A. Rogers, of Harvard College Observatory, Cambridge.

At that time he was engaged in determining and investigating standards of length for his professional use with the view, especially, of establishing a standard inch for the use of the railroads of this country. This was for the purpose of bringing about the practical adoption of a standard screw thread for the Master Car Builders' Association.

A committee had been appointed by the association and had previously been in existence a number of years, but owing to the variation found to exist in the gauges used up to that time for these thread sizes it was found absolutely necessary to determine upon fundamental standards in order that the gauges representing these sizes should be properly constructed. This was particularly necessary in order that all taps and dies made for their use by the various manufacturers of the country should produce results which would be practically interchangeable. These adopted thread sizes were and are the same as were recommended and adopted and since then in use by the United States Navy Department, authorized by the Secretary of the Navy in 1868.

This screw-thread system, as you may know, is designated by the navy board appointed to consider the matter as the "Sellers," it having been proposed by Mr. William Sellers, and having been recommended by the Franklin Institute and, as stated, adopted by the Navy Department, is also known as the Franklin Institute or United States standard thread, the latter being, however, most commonly used.

This system has a definite diameter for each size bolt or screw from one-fourth of an inch to 6 inches, inclusive, and has a definite number of threads per inch for each. It has also a flat top and bottom of the thread of one-eighth of the pitch, and an included angle of 60°.

These standard thread sizes, having thus been adopted by the Master Car Builders' Association for the use of the railroads of the country, were found to be, for a number of years, almost a dead letter, for the reason that the manufacturers of taps and dies were not able to make their product sufficiently uniform to insure satisfactory interchangeability in bolts and nuts for the service of the railroads, as taps and dies made by one manufacturer would not produce results that would interchange with those from taps and dies made by others. So in order to have a standard firmly and fully established it was necessary, fundamentally, to obtain the lineal dimensions of a standard inch and its subdivisions, and also, of course, the multiples of it.

This work was intrusted to Professor Rogers to determine these standards. I had the honor and privilege of being associated with him in this work, carrying out the physical investigations and the practical application of the standard inch thus obtained. The transfer of the imperial yard was made to a standard yard bar for the use of the Pratt & Whitney Company, of Hartford, Conn., with which company I was connected for nearly twenty-three years, until October, 1902, and from which transfer a hardened steel graduated bar was obtained, with the standard subdivisions of the inch and lineal dimensions for every detail of measurement for these reference stand-

ard thread gauges definitely fixed by microscopic lines upon its surface. This evidently required the closest study and application, and, as is also evident, it was necessary that the inch, once established, should be standard and should remain constant for this purpose for all time.

A set of thread gauges was made for the Master Car Builders' Association, on their recommendation, by the Pratt & Whitney Company, to represent exactly each of these adopted thread sizes, to enable the railroad companies to have for reference something tangible—not simply tabulated figures for the sizes and data, but something that could be used for practical reference and measurement in cases of dispute. This set of reference gauges was deposited in the archives of the association about one year later. Then, in order to insure uniformity in taps and dies, and consequently for the threads of nuts and bolts, duplicates in gauges made of hardened steel were furnished, not only to the manufacturers of taps and dies, but to the railroads, for the proper inspection of these articles, making it practicable to secure and to maintain the desired interchangeability in this important detail of the service otherwise impossible.

It has been often stated publicly and confirmed personally by officials of railroad companies that the saving this has effected in cost of repairs and time required for the work saved in what would otherwise be serious delay in cars in transit amounts to millions. In fact, it can not be estimated merely in dollars and cents. The vast interests involved are so well known and appreciated that it is unnecessary to enlarge upon this here.

I was also, as a member of various committees, directly connected with the establishing of many other adopted standards for railroad service, all based fundamentally upon the inch and the foot, as determined by the invaluable work of Professor Rogers, limit gauges for round iron for bolts, locomotive wheel centers and tires, with allowances for each adopted diameter for amount of shrinkage within limits of safety; details for the dimensions of air-brake couplings; automatic couplers for freight and passenger cars, the latter a positive requirement, fixed by act of Congress, it being so important a matter for guarding the safety of employees; pipe threads and fittings, the Briggs Standard, for which is now the adopted standard for the country as it is for the railroads; gauges for wheel flanges; diameters of axles and journals and for the thread of car wheels to insure the interchange of cars throughout the country; in the use of the also adopted gauge of track, 4 feet $8\frac{1}{2}$ inches, as well as the many adopted standard details of car construction, and those adopted for motive power and equipment by the American Railway Master Mechanics' Association. This is mentioned here to show the fact of these standards having been established and in use, and to refer to the fact that this uniformity has tended to the reduction of the cost of construction, maintenance, and repairs, and if they are to be retained must, if the metric system becomes, eventually, the only legal standard for measures of length, as is hoped by the advocates of the bill, be known and measured only by their metric equivalents. The incommensurability of the English and the metric systems simply makes this impracticable and would not be tolerated. If, on the other hand, these

standards are to be altered, even slightly, to allow of their dimensions being expressed in integral metric dimensions, what then becomes of the present recognized uniformity?

The CHAIRMAN. The gentleman's time has expired. Mr. Dale has ten minutes.

STATEMENT OF MR. SAMUEL S. DALE, EDITOR OF TEXTILE WORLD RECORD.

Mr. DALE. Much of the time of this committee has been occupied with a discussion of whether the Littauer bill involves a change of sizes in products manufactured for the Government. I desire to call your attention to a few examples taken from the textile industry which illustrate the operation of the bill in this respect. Here is a specification, No. 624, signed by C. F. Humphrey, Quartermaster-General of the United States Army, for cotton duck, 8 ounce, piece dyed, khaki shade. It calls for a fabric with 34 threads to the inch of filling. This is equivalent to 13.4 threads per centimeter. If the fabric is left unchanged and the threads per inch expressed by the metric system, the manufacturer is confronted with the impossible task of counting a part of a thread. The set of textile fabrics is always indicated by even threads. When counting the threads by the aid of a pick glass, a part of a thread appears in the form of fibers projecting beyond the edge of the plate. Thus the observer in the mill will count the threads per inch and announce it as "34 threads and whiskers." In many fabrics, however, 1 thread per inch makes a very important difference in the weight and appearance of the cloth. In this specification it would be necessary either to drop 0.4 of a thread or add 0.6 of a thread per centimeter (1 to 1½ threads per inch) in order to obtain a whole number of threads. This means there is a decrease of 3 per cent (one-fourth ounce) or an increase of 5 per cent (0.4 ounce) in the weight of the fabric. We thus see that it is impossible to express the present fabric in metric sizes because it involves counting a part of a thread, while changing the set to an even number of threads per centimeter would cause such a large decrease or increase in the weight of the fabric as to make it necessary to remodel the goods in order to keep the weight unchanged. The specification calls for a tensile strength of 75 pounds to one-half inch. This would be equal to 26¾ kilograms per centimeter. While the tensile strength of goods can be thus expressed on the metric basis, there is no advantage in doing so.

The weight of the goods as now given is 8 ounces. This is a concise, business-like expression. The ounce has been selected not because of a law compelling people to use it, but because it is a convenient unit to express the weight per yard of textile fabrics. If we reduce it to a metric basis we obtain 247 grams per meter. This is an awkward expression involving the use of three figures and giving an unnecessary degree of refinement to the expression of weight. The gram is thus too small to indicate the weight of goods per meter, while the ounce answers that purpose perfectly. Under the interpretation of the Littauer bill, by which sizes are unchanged and expressed in metric equivalents, we should be compelled to use the expression 247 to 263 grams per meter, instead of 8 to 8½ ounces per yard, as at present.

The CHAIRMAN. Why not take an even 250 grams per meter if the gram is so small?

Mr. DALE. That would be changing the weight of the goods.

The CHAIRMAN. Not materially if a gram is so small and if you can say 8 to 8½ ounces.

Mr. DALE. If you change 250 to 265 grams you change the limits of tolerance, which involves a change in the construction of the fabric. That is contrary to your interpretation, which I am discussing, and which involves keeping the sizes the same.

The CHAIRMAN. I say, on your theory that there will be a change.

Mr. DALE. Then it will be necessary to remodel the fabric. There is no question about that. Now, let us illustrate this phase of the question by yarn counts. The number of cotton yarn indicates the number of 840-yard hanks per pound. It is not, as Mr. Littauer seems to think, an arbitrary thing. When we say twenties cotton we mean that the yarn measures twenty 840-yard hanks per pound. Suppose these sizes remain unchanged and are reduced to metric equivalents we then have 768-meter hanks per 453 grams. At present we have unity and 840 yards; the latter being divisible by every digit except 9, it fits well into what the supporters of this bill call "our heterogeneous weights and measures." Eight hundred and forty yards per 7,000 grains is equal to 120 yards per 1,000 grains. I could point out other useful relations if time permitted.

The point I desire to make now is that if sizes are left unchanged textile manufacturers will be compelled to use such awkward expressions as 768 meters per 453 grams instead of the convenient expression 840 yards per pound. French and German technical works are filled with such awkward expressions, which have resulted from reducing English sizes to metric equivalents. The textile manufacturers in Continental Europe are struggling to escape from this confusion. The difficulty in the use of metric equivalents of English sizes supplies one of the strongest motives for their desire to have us adopt the metric system.

Mr. LOVERING. In determining the count of yarn, is it not customary to reel 120 yards, put it in a balance, which is in every mill, and which gives the number of grains per 120 yards?

Mr. DALE. Yes, sir; the yarn count is then obtained by dividing 1,000 by the number of grains in the weight of 120 yards.

Mr. LOVERING. You arrive at the number in that way?

Mr. DALE. Yes, sir.

Mr. LOVERING. If you were going to adopt the same process for arriving at the number by meters, would you not have to have a new scale?

Mr. DALE. You would; yes, sir; a new scale and new reels.

Mr. LOVERING. There are hundreds of thousands of these scales all over the United States?

Mr. DALE. Yes; and then there are the drawing and spinning machines. Our counters for counting hanks are based on 840 yards.

Mr. LOVERING. And is not the front roll 1 inch in diameter?

Mr. DALE. Yes, sir.

Mr. LOVERING. And does this not introduce another complication?

Mr. DALE. A very serious complication. To pass this Littauer bill and force us to use these metric equivalents means that we must use such inconvenient expressions as 768 and 453.

The size of carded woolen yarn is expressed by the number of 1,600-yard hanks per pound. This is equal to 100 yards per ounce. This enables the ounces per yard to be calculated by a simple division. Thus, to find the weight of a 3,000-end warp of 4-run yarn, 3,000 is divided by 4, giving 7½ ounces per yard. If we use metric equivalents for the run system, it will be necessary to make this calculation as follows: $(3,000\times453)\div(1,463\times4)=232$ grams per meter. Retaining the run sizes unchanged, this makes two extra operations necessary—multiplying by 453 and dividing by 1,463.

The CHAIRMAN. You have only one minute more.

Mr. DALE. In that one minute I want to state that in 1849 Spain adopted the Littauer plan of trying the metric system on the Government dog, with the object of bringing about the adoption of the metric system by the people. This plan has been carried out since that time without a shadow of change in Spain and her colonies. When the Philippines came into our possession after the Spanish war, the Littauer plan had consequently been on trial for more than half a century. This photograph [showing photograph], taken in 1901 on the docks in Manila, shows how completely this plan of introducing the metric system has failed there. It shows a group of Spaniards and Filipinos in the very shadow of the custom-house, where the metric system has been compulsory for more than half a century, weighing mats of sugar for export by the Spanish arroba. If you will look closely, you will see the letters "arr," meaning the arroba, and the figures, possibly 50, are partly hidden behind the man's head. This is the condition, as far as I can learn, throughout the archipelago. The people have refused to follow the Government's example. and it seems to be conclusive that adopting the metric system for Government work will not result in its adoption by the people.

Mr. GAINES. In other words, it looks to me as if they were weighing a lot of pigs about 6 months old on an ordinary pair of steelyards.

Mr. DALE. The metric system has been compulsory in the Philippine custom-house for more than fifty years and the people will not use it.

Mr. DRESSER. Now, then, if it has been in vogue so long in the Philippines and they do not use it, what is the danger of passing this law for the United States? Would we be hurt by it if you don't use it? This law does not compel people to use it.

Mr. DALE. The objection to it is that under a government of, by, and for the people it would create a system of weights and measures for the Government different from that of the people, creating diversity and destroying the uniformity that should be the object of all your legislation.

STATEMENT OF MR. HENRY H. SUPLEE, EDITOR ENGINEERING MAGAZINE, OF NEW YORK AND LONDON.

Mr. Chairman, I am a member of the American Society of Mechanical Engineers, the Society of Civil Engineers of France, and the Society of German Engineers. I do not propose to say much about the metric system itself, because what I have had to say is already in the report of two years ago, but I desire first to add a few documents to complete that record.

I believe, and I think these will help me to maintain that point, that measurements persist in accordance with the importance of commercial interests. The measurements relating to the draft of vessels, data referring to matters which involve the control of harbors, are almost entirely under the control of the influence of Great Britain, because of the immense preponderance of Great Britain in marine matters. I have here a number of copies of the French Journal de la Marine. This is their leading naval paper. I have marked a large number of passages in this paper showing where the speeds of vessels are almost invariably marked in knots, because practically all the records and data concerning the speeds of vessels throughout the world are in knots, and the French metric-using country has found it preferable to use the knot rather than to express the same thing in the metric system.

I am not arguing for or against either system, but simply illustrating my statement that measurements persist in accordance with the importance of commercial interests. In this you will also find measurements as to the distance vessels can go from one coaling station to another expressed in British nautical miles; and you will find the draft of many of the vessels expressed in English feet. This is simply to show that those are not merely verbal statements, but taken from current literature. These journals are of recent date.

I have here also a copy of the Schiffbau of March 14, a leading German paper along the same lines. The leading article is a description of a new German transport for conveying troops to the Orient. Most of the construction measurements are given in the metric system, but I have marked here on the second page that the draft of the vessel is given in British feet. The maximum draft 22 feet, and then auxiliary to it there appears the equivalent 6.70 meters; or 26 feet, also translated, that making 7.925 meters, and the speeds at those two drafts are given as 12½ knots and 11¾ knots.

The CHAIRMAN. A knot is a nautical mile?

Mr. SUPLEE. No; a knot is the rate of speed which, if continued, will give you a nautical mile in an hour.

The CHAIRMAN. What does 20 knots mean?

Mr. SUPLEE. It means a vessel going at a speed of 20 knots would cover a distance of 20 nautical miles if that speed were continued for a whole hour. It is a rate of speed, not a distance.

The CHAIRMAN. But it corresponds to so many nautical miles an hour?

Mr. SUPLEE. Yes, sir; but if you use the term "miles" the time element must also be introduced. If you say so many miles you must also say per hour, in order to express the speed; but if you use the word "knot" you should not use the words "per hour." It is incorrect to say so many knots per hour.

The CHAIRMAN. Suppose I said a knot an hour, what would it mean?

Mr. SUPLEE. It would mean an acceleration, corresponding to a knot faster one hour, a knot faster the next hour, and so on.

The CHAIRMAN. Then 20 knots per hour would mean what?

Mr. SUPLEE. It would be an acceleration, represented by a curve, going up at such an increasing rate that it would soon get beyond practical limits.

The CHAIRMAN. But when you say a vessel goes 20 knots an hour you mean it goes 20 nautical miles an hour, as a matter of fact?

Mr. SUPLEE. That is an incorrect expression. You will find it given according to my statement in all the standard works of reference.

But that is aside from the question here, which is when they speak of the traveling radius of action of a ship they say miles, and when they speak of speed they say knots.

I have here also a copy of the Transactions of the Society of Civil Engineers of France, of which the principal contents are an article about ships driven by steam turbines, and in it the speeds are given in knots and the radius of action in nautical miles. I have here a page from the Swiss building journal, the Schweizerische Bauzeitung, of the 27th of January, in which the greater part of the first page is taken up with an advertisement for the sale of a piece of land of an area of 7 juchart, this juchart being the equivalent of the English acre, which was their measure of land before the metric system came into use, and is still what they use.

Mr. GAINES. Is there any equivalent in the metric system of the knot?

Mr. SUPLEE. There is no equivalent; it would have to be stated as kilometers per hour.

Mr. GAINES. Is there for the mile?

Mr. SUPLEE. They use the word mille, which is the French translation of the English mile, and means the English mile; but if they wish to express rates of speed they have to say kilometers per hour, having no single unit for that purpose.

The CHAIRMAN. A knot is neither in one system nor the other?

Mr. SUPLEE. Yes; it is in the British system, because it involves the English nautical mile of 6,080 feet per hour.

Mr. GAINES. Then marine measures of speed are counted in knots?

Mr. SUPLEE. Yes; marine speeds are counted in knots, and marine measures of distance are counted in nautical miles.

I have also a statement here of the American Chamber of Commerce in Paris answering a number of questions. Some of those are misleading, because fully one-third of it is given to a consideration of the centigrade thermometer, which is not a part of the metric system at all, and simply constitutes so much padding. But this statement is repeated in substance more than once—

> The only notable exception is to be found in those industries or trades in which foreign nations which have not yet adopted the metric system have such a prepondering influence as to, thus far, impose the use of their own measures.

I only have a few more words to say. I am a technical editor, and I have the opportunity of being in touch with a great deal of work going on among manufacturers and among some scientific men. I find here in the New York Herald a very pleasant article, saying that manufacturers who have been misled into the belief that the Littauer bill, providing for the use of the metric system in the Government Departments, would cause them inconvenience and expense in the way of changing machinery and tools, have been set right by the chairman of the committee, Mr. Southard, the chairman going on to

explain, according to this article, that the metric system is not going to cost very much money or involve very much inconvenience.

The CHAIRMAN. Do you say I have written such a letter?

Mr. SUPLEE. No, sir. This is an article referring to the position of the chairman of this committee.

The CHAIRMAN. It relates to this bill. The statement is in reference to what this bill would do?

Mr. SUPLEE. Yes.

The CHAIRMAN. Not upon the general introduction of the metric system?

Mr. SUPLEE. No. The actual feeling among manufacturers and men who receive communications of this sort stating that the Littauer bill is not going to cost much or be of much trouble, speaking from the experience I have had with them, and from many conversations with them, and from my general information of the temper of the manufacturers, if I may say so with all consideration, must be distinguished as exasperating. I do not think that you gentlemen realize the deep and intense feeling that exists among the great majority of manufacturers and the workingmen about this matter.

The CHAIRMAN. For or against it?

Mr. SUPLEE. They are opposed to any legislation. The great majority want you to keep your hands off our standards.

Mr. GAINES. This feeling exists among whom?

Mr. SUPLEE. Among manufacturers, engineers, and that class.

The CHAIRMAN. What engineers?

Mr. SUPLEE. I mean constructing engineers, heads of manufacturing establishments.

Mr. LILLEY. What is your opinion?

Mr. SUPLEE. My own opinion is that it should be left absolutely to the choice of the men using it.

Mr. LILLEY. In other words, you say leave the law as it is?

Mr. SUPLEE. Leave the law as it is.

The CHAIRMAN. The gentleman's time has expired.

Mr. Gingrich, of the Cincinnati Metal Trades Association, is recognized for seven minutes.

STATEMENT OF MR. CHARLES S. GINGRICH, OF THE CINCINNATI MILLING MACHINE COMPANY.

Mr. GINGRICH. Mr. Chairman, I come here representing the Cincinnati Metal Trades Association, an association with a membership of 56 manufacturers engaged in the metal trades, who have invested in their different business enterprises a combined capital of $4,000,000 approximately. They pay out for labor every year about $2,250,000; taxes about $200,000. They employ all together about 7,500 men, and in the past year did a business in the aggregate of over $7,000,000.

It was pretty generally agreed here yesterday, and in the former testimony, that the result of this bill would be to eventually reach into the private life of every citizen of this country and also into the manufacturing industries. I believe 90 per cent of the members of Congress will agree to that statement. So we will pass over that.

The point that is of importance to us manufacturers is the ultimate effect all this would have on our business. We must manufacture to standards. We must use standards made either to one system or

the other. The two systems can not be reconciled in the machine shop. That has been thrashed over so thoroughly that I do not believe I need to go into that at this time. I believe every intelligent mechanic agrees with that statement.

If we could go from our present system to the new system in a day and throw everything away—that is to say, wipe out the old and substitute the new—that would probably obviate a certain element of confusion that would otherwise necessarily result; but that sudden change can not possibly happen; we all know that. We know that you would expect us to use the two systems, and that would mean a duplicate set of everything we use in the way of patterns, drawings, fixtures, gauges, jigs, and all special as well as standard small tools; in fact, our entire set of working tools, so to speak. The cost of all this, therefore, is a very vital thing to the manufacturer; and I am speaking to you, gentlemen, not from any theory that I may personally have, but from an exact knowledge of the facts gained by being actively engaged in the business and as a practical man in the shops among men who have to measure things. I know that the expense of this to manufacturers would be an amount that would be not less than one-fourth of their working capital. Every one of you business men present, whether you are manufacturers or not, know you can not afford to deliberately dump into the gutter one-fourth of your working capital. If you did it would ruin you; and this thing would ruin us. That is the point I want to make here to-day.

It is true that if by setting aside that amount of money we could look upon it as an investment from which we could in the future gain certain returns, it would be a wise move. Do you think there is a single manufacturer in the country to-day that would not have set that amount of money aside long ago if he saw a good chance of gaining by it? Manufacturers are in business for gain; they are not in it for the love of it, and they would not overlook an opportunity like that.

It has been mentioned, I believe a number of times, that this sort of thing is important in order to get harmony with the nations of the earth, in order that we may facilitate our commerce and that sort of thing. It has been pointed out before you, and pretty strongly, that the people of the earth who trade—that is, a majority of them—are using the English system to-day, so that the logical system of commerce should be the English system. But I want to bring out another point. I have had personal experience with the company I am with in dealing with foreign nations, and we are to-day sending a large amount of our product into France and into Italy. They do not ask us for a metric machine. In fact, they accept machines made to our standards, and they have gone further and have filed with us a standard specification in regard to arbors which states that all arbors going with machines must be made to English measurements; in other words, they want the English (or American) standard arbor.

Mr. GAINES. What is an arbor?

Mr. GINGRICH. That part of the machine on which the cutter is mounted. The cutter must fit snugly on that arbor. In their machines they are using to-day cutters with English standard holes,

and they want us to supply machines fitted with arbors made that way. The fact is that those few countries that do use machines with metric cutters do not do those things that these gentlemen have told us about in the past few days—that is, use an arbor or a cutter which has a hole according to the English system, called by another name. The metric standards are entirely different things. For instance, the metric standard arbor, which comes nearest to being the equivalent of our 1-inch diameter arbor, is not 25 and a fraction millimeters, it is 27 millimeters. Do you realize the importance of that point? It shows that their standard size for a part intended to do the same work is an entirely different thing than ours, and the difference is so great that we can not substitute one for the other. Parts to interchange must be made to one or the other standards. The system does not cut much figure once the standard has been adopted.

Further, in regard to export business, I am speaking not from hearsay in regard to this European business, but from my personal contact with it in our office and from the knowledge that I have gained from our personal representatives in Europe. We have two men over there all the time working up business for us, in connection with our regular European agents. These men are specialists for us, finding out what the Europeans want. If they were calling for metric machines, we would have been making them long ago.

Now, as I said before, if by doing this thing we could gain something we would be very glad to do it, and we would have done it long ago; we would have taken advantage of the statute of 1866 and adopted the metric system. As the matter stands it will involve a tremendous expense, without any show of getting a single dollar in return or of being benefited in any way whatever. It will not enable us to make more machines nor better machines nor cheaper machines, and it will not enable us to sell more of them. Then what will be gained? Not a single thing. It will not even be a luxury.

The CHAIRMAN. The gentleman's time has expired.

STATEMENT OF MR. L. D. BURLINGAME, OF THE BROWN & SHARPE MANUFACTURING COMPANY, OF PROVIDENCE, R. I.

Mr. BURLINGAME. I represent the Brown & Sharpe Maunfacturing Company here to-day in opposition to this metric measure which is before us for discussion. Our company, at the time when I appeared here two years ago, had about 2,500 employees. Now we are approaching 4,000, and our works are rapidly growing. We have very large sales of machinery and tools abroad in metric countries. At the great international expositions we have exhibited our machines and tools; at the Paris Exposition in 1900, and last year at Liege, Belgium. At those expositions in metric countries we not only received the grand prize, but were awarded by the international juries the highest points of excellence of any machine-tool manufacturers in the world.

In considering this metric bill and its adoption by the Government, we do not feel that such legislation is necessary or desirable for the extension of our business. We can use the metric system as

much or as little now as we wish in extending this business which I represent here to-day. The effect of this bill in introducing the metric system into the Departments of the Government would, in our business, be objectionable and would immediately be felt, from the fact that our business is every day coming in contact with the Government. We are daily figuring on Government specifications, some large and some small, and we would find it necessary to translate back and forth, as we do in a few cases now. At present we are sometimes brought in contact with the Bureau of Standards, of which Doctor Stratton is the head, where the metric system is used as far as possible, and we can see right off the troubles that would come to us if the Government adopted this system. The Departments of the Government use cutters, arbors, emery wheels with standard holes, screw machines, which have turret tools that must be interchangeable. If the Government should try to use even metric measures for these tools, which would be the case according to Doctor Stratton's own testimony before this committee, these tools, as made by us, would not interchange with those for machines in the Government Departments. We are here interested not only for the protection of our own business, but to help the Departments of the Government that they should not have the confusion and mix up which would result from the changing of these sizes, and using sizes that would not interchange with those required on older machines and that would not interchange with those we use and make regularly for the market. We feel that the Government should be the helper of the people and should try to help us in economically producing our goods rather than putting obstacles in the way of our progress.

Few of us make our product through all the stages from the raw material, and are dependent on other manufacturers for supplying many of the partly finished details. Thus we buy our chucks, transmission chains, finished shafting, emery wheels, etc., ready to go on machines built otherwise by us, and any change that did not take effect simultaneously in all of these correlated lines would lead to misfits, delay, and annoyance. Even when these were avoided it would require doubling up of stock. This is illustrated by the emery wheels. The Government has a large number of our grinding machines in use, for which they are constantly ordering emery wheels. Such wheels have to be kept in large numbers to give the required grade and hardness for a given job. We have in our grinding department 16,000 wheels, valued at an average of 50 cents each. Now, let a change be made in the machine to an even metric size of arbor for the wheel, new machines standing beside old ones must have a new set of wheels, and this great investment would have to be doubled, besides the great inconvenience. When customers order new wheels we would be in doubt as to which size to send.

In regard to the loss to the workmen, I mentioned yesterday that there would be a personal loss to them, especially in our mechanical lines of work in the machine shops of the country. Among our 3,800 men we have a great many machinists; we have many draftsmen, sheet-metal workers, carpenters, pattern makers, and tool makers, and in a greater or lesser degree all these men would lose by changing their kit of tools to use metric tools. It has been said that the adoption by the Government only would not change the tools that these men use. If we have to deal with the Government—if the

shops of the country should, on account of this measure, eventually be brought into the metric system, as can be the only purpose of this bill, we would have to change—if it did not come this year or next year or for ten years, still the time would come when we would have to incur this great expense and we would have to suffer accordingly.

Mr. LILLEY. What do you mean by "we?"

Mr. BURLINGAME. The Brown & Sharpe Manufacturing Company and their employees, the people I represent here to-day. Our machinists, our mechanics, and these different classes of workers that I speak of.

Mr. LILLEY. Would you not have the opportunity to build an entire new set of tools?

Mr. BURLINGAME. Even if we did we feel our loss would be so much greater in making the change as to far outweigh any gain from increased sales of our tools.

The CHAIRMAN. You make the Wilcox & Gibbs sewing machine?

Mr. BURLINGAME. Yes.

The CHAIRMAN. Are you still of the opinion that if this bill were passed it would necessitate your changing the tools you use in the manufacturing of sewing machines?

Mr. BURLINGAME. I am still of the opinion that those drawings would have to be re-marked in the metric system.

The CHAIRMAN. You mean when the whole country has come around to the use of the metric system?

Mr. BURLINGAME. Yes; and that can not be.

Mr. GAINES. And if the Government called upon you to make a tool by the metric system, you would have to change your tools?

Mr. BURLINGAME. We might to a great extent. I don't say we would have to redesign the sewing machine, but we would have a great deal of trouble and difficulty on account of the change.

It has been said that opposition to this bill before the committee centers in a few, and that such opposition has been stirred up by a propaganda emanating from these few. Mr. Chairman, I can assure you, if the feeling among the foremen and workmen of our shops is any criterion, that the opposition is widely extended. If these men realized that there was the least possibility of this measure becoming a law they would let their voices be heard with no uncertain sound in opposition. I can assure you of this because of what I have heard these men say among themselves and when I have talked with them on the subject, and I feel sure this same feeling extends throughout the country. Now, if there is any propaganda worked up by the few and kept alive by them when there is no popular demand or desire for it it is this prometric movement, and if it were not for the agitation by a few men that have been persistent in advocating it we should hear very little of it in this country.

When I was in St. Louis two years ago at the exposition I saw some of our standards in the Government exhibit, and a notice was beside them to the effect that the metric system was now the basis of measurement in our country, and the attendant in charge volunteered the information that the metric system was the coming system of our people, and after explaining its points of merit said that our standard yard was not an accurate or satisfactory standard, and that eventually all our system would be developed and measured from the

metric system. That no doubt emanated from a source that has been trying to spread this propaganda.

Mr. GAINES. What was that man's name and who put him there?

Mr. BURLINGAME. Whoever had charge of the exhibits of the Bureau of Standards at the St. Louis exposition.

The CHAIRMAN. The gentleman's time has expired.

Mr. GAINES. What was his name? You can tell me privately if your time is gone.

Mr. BURLINGAME. I understand that Doctor Stratton is at the head of the Bureau of Standards. I can not say, however, that he was responsible for what this attendant in charge there at the exposition said.

STATEMENT OF ERNEST F. DU BRUL, OF THE MILLER, DU BRUL & PETERS MANUFACTURING COMPANY, CINCINNATI.

Mr. DU BRUL. Mr. Chairman, I am one of those people designated in this morning's New York Herald as the "clique of manufacturers" opposing this legislation. I think that the committee would find out, if they had a chance to investigate as fully as possible, that this clique will probably include every manufacturing community of this country before we get done.

The arguments that have been presented to this committee in previous hearings, and in this hearing on the side of the proposers of this bill, men of high scientific attainment, men who are engaged largely in computing, without handling physical, actual things in their own hands, simply reminds me of the immortal saying of Professor Nix, of the yellow supplements, "That is what it is to be a scientific." [Laughter.]

These gentlemen come here very much like the 11 obstinate jurors who could not be convinced by the one man who had it all right. They have not a dollar at stake in this thing. They won't lose anything. They can not imagine the cost that would result from this legislation for a factory doing Government work, and that is what I want to apply my talk to in the few minutes that I am allowed.

These gentlemen seem to need education on other matters besides computation. They seem to need education in logic; they seem to need education in psychology. Mathematical and scientific training is supposed to develop the logical quality, but I fail to find any logical argument that is based on practice. The arguments of those highly scientific gentlemen are all based on highly scientific theories. We deny their major premise which is, that it would not be difficult to work the way they propose under this bill. So much for their logic. As for psychology, we think they are very deficient because they can not realize the amount of practical applied psychology that will fall to the lot of the unfortunate manufacturer, who would have to turn over his ordinary, every-day workmen a set of drawings written in a language foreign to them, and one in which they can not think, reason, or calculate. They need an education in history, so as to properly view the historical features of the adoption of this metric system in other countries, and the effect of it; they need an education in economics to see what the effect of this thing is going to

be, and the cost to those making things for the Government, as well as to the Government itself. And most of all they seem to need an education in that fundamental principle of science, which is, to get at the truth—because if science does not get at the truth it is not science at all, and after getting the truth, they should learn to stick to it. If this campaign for the adoption of this bill has any merit, it surely does not need misrepresentations in the New York Herald, or any other publications to help the metric system along.

The machinery of this country, or of any other country, is the foundation of its civilization. To-day you must depend on the machine shop to make the machinery to make everything else we use. The Government to-day depends on the machine shops making the machinery to make our guns and ships and other things, affected by this thing, so that those shops and the machinists in those shops, as well as those in the Government shops making the guns and ships, and the men in the architectural departments making the buildings for the Government, are all affected by this bill.

Mr. GAINES. How?

Mr. DU BRUL. They will be affected in this way: A battle ship, a machine shop, or a building is but one vast embodiment of measurements fixed in metal, wood, or stone. Just grasp that idea. These scientific men like Mr. Raynal can make their computations, and after they have done the computations have a scientific value. They are on a piece of paper, which may be filed away or may be blown away, but when those computations are built into the metal of a battle ship they endure until the metal is melted down or destroyed in war. Now, then, the number of men engaged in computation right in the navy-yard is infinitely small as compared to the number of men engaged in embodying those computations in metal in our battle ships and our guns. He himself confessed yesterday that he could not readily read technical literature in German or French or Italian in the metric system, yet he wants to get American technical literature written in a language of measurements that he himself is confused with. No matter at what cost, he wishes to throw into worse confusion the thousands of mechanics building the things that his department is making plans for. Just think of that. To try to save confusion for the few men who draw bigger salaries, and therefore we judge have more brain power than the ordinary man working in the navy-yard, yet who are confused in spite of the metric system, he is going to throw the great mass of men into worse confusion, men who haven't as much brain capacity as those trained men of science. They are not trained in the same way, and the confusion among those men will be far greater than it is or ever will be among the intelligent men who are doing our drafting and designing.

What becomes of the scientific accuracy of these gentlemen? If there is anything that they must pride themselves on, it is their scientific accuracy. And yet they ask us to practically accept 25 millimeters as an inch and throw away the other four-tenths. We work to a half of a thousandth and a quarter of a thousandth—sometimes to the tenth of a thousandth—we ordinary greasy mechanics in machine shops. One thousandth is a common measurement. Still they would ask us to throw away nearly two one-hundredth of our inch. Why? They realize that they simply can not continuously

keep on with a lot of decimal fractions at the end of their converted but bastard measurements. They simply can not do it. They would be idiots if they did. They admit that. And as a result in order to get uniformity and the even millimeter, they would throw away these decimals that are now embodied in our inch and which we can not get away from.

The very highly scientific chemical men have shown good sense in not attempting to bastardize the metric system and making it like the army mule, without pride of ancestry, or hope of succession, by converting the English measurement into metric equivalents, and they are using the metric system in all its pristine purity and beauty. They could get away in chemistry from the English measurement because chemistry is a matter of weight and not measurement. Even Professor Newcomb would not dare to suggest to the astronomers of this world that they subdivide the circle decimally instead of its present subdivisions, because Professor Newcomb would realize in his own line that such a course would simply nullify all astronomical work of the past and make useless for comparison the records of the past with those of the future. Yet, unfortunately, Professor Newcomb can not seem to realize that there is literature of engineering as well as there is literature of astronomy, and that the literature of engineering is in far more general use than the literature of astronomy.

Mr. Monahan, a good friend of mine, practically admitted here yesterday that the textile industry of Germany is tied irrevocably to the textile industry of England, where the standards used in the textile industry were first started. They are English standards. Our railroads are tied irrevocably to the standard gauge, not only in this country, but throughout the world, of 4 feet 8 inches, an odd half inch getting into that measurement because some fellow didn't have a good rule. The railroads of the world were built to that standard because the Continental railroads got their first locomotive from England, as we did. Our standard gauge is 4 feet 8½ inches, just as theirs is, and we are tied to that mistake in some fellow's rule and can not get away from it any more than they can.

The CHAIRMAN. Do you think the passage of this bill would change the standard gauge on railroads?

Mr. DU BRUL. No. I have just said that you can't change it, no matter what you call it, but I wanted to illustrate that no matter what preconceived notions any metric fanatic may have about these things, you can not get away from the standards that are established.

The CHAIRMAN. Why would it not change that as well as any thing?

Mr. DU BRUL. Because they could not get away from it. This bill will throw away and nullify the millions of dollars that have been spent by this Government in its land surveys for the same reason that humanity is tied to the measurements of the past.

I was up in Montreal the other day, and I there learned something about the land surveys in Canada. The eastern counties of the Province of Quebec were surveyed by the English system, and land there is sold by the acre. In the other counties—the French counties—the land was surveyed under the old French system, and is sold by the arpent. The land in the same province is bought and sold by

two different systems of measurement, right on our northern border. We all know the long surveyor's chain in Philadelphia and what confusion that has caused by making 100 feet in certain parts of Philadelphia a few inches longer than the standard because of the confusion of records that would otherwise result.

The CHAIRMAN. The gentleman's time has expired.

STATEMENT OF MR. A. M. MATTICE, CONSULTING ENGINEER, NEW YORK CITY.

Mr. MATTICE. I come down here at the instance of the manufacturers' association, of New York. I have had an engineering experience of thirty-two years. I graduated from the Naval Academy in 1874, was fifteen years in the Engineer Corps of the Navy, and have been seventeen years in civil life. In civil life I have occupied a number of positions, including that of chief engineer of both of the large Westinghouse companies, also chief engineer of the Allis-Chalmers Company, the largest builders of steam engines in the world.

In these various connections I have had a number of occasions to go abroad on business. All of these companies have affiliated companies with which they are cooperating in Europe. I have come in contact and am intimately acquainted with leading manufacturers on the other side, both in England and on the Continent. As chief engineer of the Allis-Chalmers Company I have had occasion to come into business relations with German manufacturers, and especially with the largest machine-manufacturing concern in Germany, the full name of which is Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nurnberg Aktien Gesellschaft. [Laughter.] Their works are as large as their name. I have brought with me some of their working drawings, which were sent over for the use of the Allis-Chalmers Company in building gas engines. They work under the patents of this company.

This matter has been brought up to you by one person and another. Some say that the Germans use the metric system altogether and some say they do not. I thought I would bring some documents to show you. Here is a drawing of a piston rod for a gas engine where the screw threads are given as so many right-hand threads (I am translating it), 6 per inch, English. That is the Whitworth thread, or Whitworth pitch, the diameter being made to suit this rod. The pitch, which has to be done by the lead screw of the lathe, is given as so many per inch, English. The outside diameter is given in millimeters, and as they are using a foreign thread which they find more convenient than any metric thread they could have, the diameter at the bottom of the thread has to be given in fractions of a millimeter. Here is another drawing similar to that, if you would like to see it [exhibiting drawing]. These are special diameters. When it comes to a standard-sized thread, here is a tie bolt on which the only dimension given for the bolt is 2½ inches. In the large machine shops in Germany, when 1 inch is mentioned without saying anything else, it means 1 inch English. That is in the machine shops. In the pattern shop or in the carpenter shop when they say 1 inch, without saying anything else, it means 1 inch Rhenish. In the building trades, outside of the carpenters, when 1 inch is said without

any reference to what inch it is, it frequently means a Bavarian inch. Here is a pocket rule which I got last July in Germany from the workman who was using it, giving him a new rule, so that this was not one bought only for the purpose of exhibition. It has on one edge the meter and on another edge the Rhenish inch and on another edge the London, or English, inch, and on another edge the Bavarian inch. That is a rule which is in everyday use in the German shops.

I have cited only this one company, but, as I have gone around over there I find they all, without exception the big concerns, using English dimensions for screw threads not only for bolts, but for pipe threads.

The CHAIRMAN. Whitworth's thread?

Mr. MATTICE. Yes, sir; for bolts. In this letter [exhibiting letter], which is from the Nuremburg company with reference to an engine, where we asked them for a price to substitute United States thread for the Whitworth thread, they say, "it would be very difficult to substitute the American thread for our standard Whitworth thread." I put that in evidence, showing that they considered that their standard—the English Whitworth thread.

The other large machine shops are doing the same thing. They find it more convenient to use the binary scale for screw-thread work, as well as using a standard where they could get good tools for it from England, which they are now copying, but formerly they got them all from England, rather than to institute an entirely new standard on the metric system.

The CHAIRMAN. You are speaking of screw threads now?

Mr. MATTICE. Yes; both plain screw threads and pipe threads. Another case which has been spoken of is Willans & Robinson, of England, who are said to have used the metric system.

Mr. TOWNE. For thirty years.

Mr. MATTICE. I think I am better acquainted with the nature of their work than anybody else in America, because we have had dealings with them, and I have made frequent trips to their works, and they have to ours. They have not used the metric system except this: They have put their dimensions on their drawings in millimeters. The draftsmen think in English, figure in English, figure up their drawings in English, and then translate them into metric dimensions. Here is a book of metric equivalents which I got at Willans & Robinson's. Every draftsman has one on his table and he figures his drawing in millimeters or fractions of them, and it goes to the shop, and some measurements in the shop are made in millimeters, but all the fine measurements in English. All fits are made in thousandths of an inch.

The CHAIRMAN. Where is this Willans & Robinson's Company?

Mr. MATTICE. Willans & Robinsons, Victoria Works, Rugby, England. Mr. Mark H. Robinson is the head of the firm now, and Mr. James C. Peache is the managing director. They find the fractions of an inch more convenient for making fits and the fine work in the shop, partly on account of the greater ease of measuring with the inch micrometer. It would take a long time to explain that to you, but I have some micrometers here and can explain why it is easier to measure in thousandths and ten-thousandths of an inch with a micrometer than to use the metric system. But that is the practical result. The screw micrometer——

Mr. LILLEY. Mr. Chairman, the witness is rushing along hurriedly. I suggest that he be given ten minutes extra, to be taken off the time of the other side to-morrow, if there is no objection to that.

The CHAIRMAN. Very well.

Mr. GAINES. I want to be absolutely impartial to both sides of this matter. Think of the enormous amounts that are involved, and we are rushing through in four hours a day. I feel generous toward both sides of this proposition. I wish to identify on the record this little book that has been referred to by the witness. It is French Measures and English Equivalents, by John Brook, for the use of manufacturers in iron, steel, etc.; engineers, tool makers, millwrights, draftsmen, foremen, mechanics, forgemen, rollermen, and artisans generally.

Mr. MATTICE. Let me go back to Williams & Robinson. As I said, they have used only the millimeters on their drawings. They have not used the metric volumes; they have not used the metric weights. All of their weights are in pounds, liquid measures in gallons, and they speak of pounds pressure per square inch. The metric system applies only where metric dimensions are used, as on their drawings, and even there they use a great many inch marks. All holes are given in inches. Here is one of their drawings, and you will see that the holes as well as the screw threads are in inches. I think they are now pretty much soured on the metric system altogether, but I will not state that positively. I have written to Mr. Peache about it, and I think I can give you something positive a little later.

The reason why it is easier to use the screw micrometer in inches than in millimeters is this: It extends back to the fact that the inch is the result of evolution, the survival of the fittest. In this screw micrometer you measure to the one one-thousandth of an inch, and by the Vernier on the barrel to the one ten-thousandth of an inch. Now, if you will look at the divisions of this metric micrometer, it measures to the one-hundredth of a millimeter. It measures two and a half times as fine as the primary scale of this English one, which is unnecessarily fine for the great bulk of work, but it is four times coarser than the finest of this English one [indicating]. You can not measure finer than this and still use a decimal system without getting down to two and a half times as fine as the ten-thousandth of an inch. I can easily measure to the ten-thousandth of an inch with this English micrometer, but I can measure only to the one one-hundredth part of a millimeter, which is four times as coarse, with this metric micrometer. The reason they do not put a Vernier on the metric micrometer to read one-tenth as fine is because it can not be seen readily with the naked eye by the workman. It can be done, of course, for very fine work, and I have no doubt that it is sometimes done, but not for commercial work.

The CHAIRMAN. There is very little work done finer than twenty-five one-hundredths of an inch, is there?

Mr. MATTICE. Why, yes; it is a regular thing. Take the standardization of engines and dynamos. The standardization committee several years ago, of all the manufactures——

The CHAIRMAN. How fine does that metric caliper read?

Mr. MATTICE. One-hundredth of a millimeter.

The CHAIRMAN. That is twenty-five hundredths of an inch.

Mr. MATTICE. It is two and a half times as small as a thousandth of an inch. Say there is an engine builder in the East and a dynamo builder in the West. The engine builder builds the engine and makes the diameter of the shaft a little larger than the bore of the generator, so that they will go together a forcing fit—that is, the part that goes in is bigger than the hole it goes into. The standard difference up to 6 inches is one one-thousandth of an inch. One one-thousandth of an inch is a good deal.

Mr. TOWNE. That plug is two-thousandths of an inch smaller than the hole, and it wabbles perceptibly.

Mr. GAINES. What is the thickness of that blade that you have there [exhibiting a feeler gauge]?

Mr. MATTICE. That is two one-thousandths of an inch. It has about one ten-thousandth inch error, but it is only for rough measurement. A thousandth of an inch is a good deal.

It has been said by some people that the electrical people use the metric system. It so happens that the electrical units were defined in metric measures, but you could just as well define them in English measures, one or the other. The person who is actually using them in calculations and in the shop never thinks what the base of the system is any more than he thinks of the length of the earth's meridian in connection with the meter, or the pendulum which somewhere beats seconds in connection with the English system. He does not think of that.

I can say to you that the Westinghouse Electric and Manufacturing Company do not in any way, shape, or manner use the metric system in America. All of their drawings, all of their calculations are made in the English measures. The dimensions are all put on the drawings in English, and they are worked to in the shop in English.

The CHAIRMAN. You mean in the manufacture of their machinery?

Mr. MATTICE. Yes, sir; and in the calculations for the manufacture. I am talking only of metal manufacturing. There may be some trades where it may be of benefit to use the other system. It is also the same with the electrical department of the Allis-Chalmers Company. They do not use a single metric measure there at all, in shop or in calculations. I can not speak definitely for the General Electric Company, but all the drawings I have seen of theirs are made in English measures. I do not think they use the metric system at all. Here is Foster's Electrical Pocketbook, which is used by electrical engineers. I have turned down a few pages given in feet and inches. That is what they use.

Mr. GAINES. Why do they have to use this book?

Mr. MATTICE. For valuable data that have been compiled by engineers. They have to refer to all these tables. It has taken years to compile this data. I use in my daily work one or another of at least twenty handbooks. Those all would have to be rewritten into the metric system. There are lots of similar data which are used by all engineers every day.

Here is a very rough thing—an ordinary pipe fitting, an inch and a half tee, used by the thousands [exhibiting fitting to the committee]. Changes and additions are daily being made in piping everywhere—steam pipe, water pipe, etc. Here is a 1½-inch tee. It is a tee which

fits a nominal 1½-inch pipe. That pipe thread is a well-standardized thing. The American pipe thread is now being used abroad. A great many German and English manufacturers are using it instead of Lloyd & Lloyd thread, which has been one of the standards of England. A pipe fitter must keep a great number of pipe fittings in stock. He has to keep ⅛-inch, ¼-inch, ⅜-inch, ½-inch, ¾-inch, 1-inch, 1¼-inch, 1½-inch, 2-inch, 2½-inch, 3-inch, 3½-inch, 4-inch, 4½-inch, and 5-inch, and then by inches up to as high as you want to go, 16 inches generally being the limit for screwed pipe.

The CHAIRMAN. You do not think there is anything in this bill that would change anything about that?

Mr. MATTICE. Yes, sir.

The CHAIRMAN. What?

Mr. MATTICE. That screw thread is made to English dimensions.

The CHAIRMAN. Does anything in this bill affect those screw threads? That is a matter of agreement in the trade.

Mr. MATTICE. No, sir. If the Government uses metric measures they have to insist on a metric screw thread.

The CHAIRMAN. Can you measure that thread with the metric measurement?

Mr. MATTICE. You can, with a great deal of difficulty. You are coming down to odd fractions. Screw threads must be measured by what they are generated by. You can not generate a metric thread with an English lead screw. You can come near it, but not exactly.

Mr. WEBSTER. How accurate must that be in order to fit—that tee? Must it fit to a thousandth of an inch?

Mr. MATTICE. No.

Mr. WEBSTER. How much?

Mr. MATTICE. In some ways it must fit to a thousandth of an inch.

Mr. WEBSTER. How accurately is that thing that you have in your hand made? Is it a thousandth-of-an-inch job?

Mr. MATTICE. It is in some ways. In other ways it is not.

Mr. GAINES. If the specification called for a thousandth-of-an-inch fit would you have to make it that way?

Mr. MATTICE. Yes, sir. If the specification called for the pitch to be in the metric system, then you must make it so. I am speaking only on the supposition that they would call for it. I should suppose that if the Government is required by law to do a certain thing the Government would obey the law if nobody else does. Even if you should attempt to make it compulsory for the people probably they would not comply with it, but the Departments of the Government would be supposed to obey the law strictly to the letter.

Government work is very special work. A great many people do not care to bid on Government work because they are so very particular, not reasonably particular, in a great many cases, because Government specifications are often drawn by scientists who have not had a practical education, or practical experience, or by very young men who have not had it. As they grow older they will see that they have put unreasonable things in their specifications.

Some of the manufacturing companies I have been connected with did not hanker after Government work, and just as often as not we would put on big prices, to go through the form but let somebody else get the job.

If the Government calls for more special work, you will find that many concerns will not bid, and the Government work will be higher priced.

The CHAIRMAN. You have, as a matter of fact, three systems of screw threads, have you not?

Mr. MATTICE. No, sir; not in this country.

The CHAIRMAN. No; not in this country, but you have about three systems of screw threads, the Whitworth——

Mr. MATTICE. There is no Whitworth system of pipe threads.

The CHAIRMAN. Is there not?

Mr. MATTICE. No, sir. There are a number of systems. In England Lloyd & Lloyd was the one used mostly, but the American system they found was worked out a great deal better, and the large manufacturers of pipe tools in this country furnish a great deal now to England as well as to the Continent.

The CHAIRMAN. Anyhow, you have two or three systems of screw threads, to which most people conform. Somebody, I think it was you, spoke of a thread that some manufacturer uses, so as to control their own repairs. Do they not do that?

Mr. MATTICE. They used to, but not now.

The CHAIRMAN. Not so much now.

Mr. MATTICE. Not any in this country.

The CHAIRMAN. That is the result of either an implicit or a direct agreement among manufacturers by which they agree to what is called a system?

Mr. MATTICE. Yes, sir.

The CHAIRMAN. There is nothing about this bill which prevents or proposes to change any system, is there?

Mr. MATTICE. I would say yes, sir.

The CHAIRMAN. I should say not.

Mr. MATTICE. They would have to work in metric measures. In working to metric measures you have to have a thread which can be generated by a metric screw, and in that way you will upset this system entirely.

The CHAIRMAN. There is an almost constant agitation about a new system of screw threads, is there not?

Mr. MATTICE. I have not heard of it.

The CHAIRMAN. Only a few years ago they got together and adopted a metric screw, and they have one on the other side.

Mr. MATTICE. I do not know of any which can be considered as standard. In France they use a few.

The CHAIRMAN. And in Germany?

Mr. MATTICE. I started to explain what the changes would mean as regards pipe fittings. This tee has three openings, each with a screw thread. The straight part of the tee is technically called the "run," and the opening at right angles to the run is called the "outlet." Now, during the period of transition to metric measures, when you have to extend, change, and repair old piping, you would have to use tees made as follows: (1) English all over, (2) metric all over, (3) English run and metric outlet, (4) metric run and English outlet, (5) English and metric run and English outlet, (6) English and metric run and metric outlet. Thus you would have to carry in stock six kinds of tees where you now carry one.

Here is another kind of pipe fitting [exhibiting same], a reducing bushing. It has two sizes of thread—one outside and one inside. During the period of transition you would have to carry in stock, instead of one kind for each size, the following: (1) English outside and inside, (2) metric outside and inside, (3) English outside and metric inside, (4) metric outside and English inside, or four times the number of kinds you now have to carry in stock, and similarly all through the line of hundreds of kinds and sizes of pipe fittings, valves, etc.

Mr. GAINES. Why do you carry them in stock?

Mr. MATTICE. For repairs and additions. During the period of transition, until every pipe now in use has disappeared.

Mr. GAINES. Certainly. So that in every piece of machinery made by the English standard, to repair that machinery, if you adopt the metric system, you have to carry two sets—one for repairs to the old machinery and the other to repair the metric machinery, to be made hereafter?

Mr. MATTICE. Yes, sir. Manufacturers are furnishing repair parts now for machinery made twenty years ago. Electric railway motors are comparatively new, but some of those which were built fifteen years ago are still in active use to-day. I asked an officer of a manufacturing company the other day, and he said that they are furnishing almost daily repair parts for railway motors furnished by them fifteen years ago.

Mr. GAINES. What is the average life of a locomotive?

Mr. MATTICE. I can not say. I am not a railway engineer. With an electric railway motor it depends upon the service. Some of the small companies in the small towns, as I say, are still running motors made fifteen years ago.

Mr. GAINES. I was talking about a locomotive.

Mr. MATTICE. As to a steam locomotive I can not say.

Mr. GAINES. All right.

Mr. MATTICE. They talk about the relations of the metric measures, the relation of the linear measures to volume and weight. In many ways that is some advantage. But the relation between linear measure and weight applies only to water, and fresh water, not to salt water; not to ships, and only to fresh water. Nearly all the comparisons, you will see, are comparisons of tanks. That is a very small fraction of the work of an engineer and manufacturer. I will cite one thing which is of more importance commercially to the manufacturer of metals, that great industry of this country, one relation between linear measure and weight which is of more importance than this relation between the linear measure and water under the metric system. In the drafting room of a manufactory the draftsmen are always computing weights for balances, strengths, and costs. They may use one material instead of another on account of weights. They are continually computing weights. Probably there are 10,000 draftsmen doing it at this moment. Suppose I have a rail or rod of iron, and its area is 8 square inches. What is its weight per yard? An inexperienced man would multiply 8 by 36 to get the volume, and then multiply it by the weight per cubic inch, and finally get at it. But all you have to do is to bring your decimal point one place to the right and you have it. Ten times the area of cross section of wrought iron is the weight per yard in pounds exactly. It is not any

approximation, but exact. That one little fact is of more importance to the metal manufacturers of this country than the relation between the meter and the volume of fresh water, because it is being used by hundreds where the other is being used by one person.

Mr. WEBSTER. Does that relate to iron or steel?

Mr. MATTICE. That is wrought iron. If for steel, add 2 per cent. For cast iron, substract 6 per cent. That is the way it is done practically in the drafting room.

The CHAIRMAN. You do not use iron rails any more?

Mr. MATTICE. No; but the 2 per cent comes in, and it is done quicker than the other, notwithstanding the 2 per cent or the 6 per cent for cast iron. That simplification of a calculation is of a great deal more advantage than the simpler calculation for fresh water in the metric system.

There were some other things that I was going to speak of, but as time is limited I think I will end here.

Mr. GAINES. I would like you to tell something about yourself. Where did you graduate? Who are you?

Mr. MATTICE. I graduated from the United States Naval Academy in 1874, in the class of engineers.

Mr. GAINES. What have you done since?

Mr. MATTICE. I was in the Navy for fifteen years, in the Engineer Corps. My first experience with the metric system was in 1877, when I was stationed at a French workshop in Marseille, in charge of the repairs of the machinery of the United States Mediterranean fleet. That was my first experience with the metric system, and I have had more or less experience with it ever since, and more within the last five years than at any other time.

Mr. GAINES. You can use both those systems?

Mr. MATTICE. Yes, sir.

Mr. GAINES. Which of the two gives you the least trouble to work at?

Mr. MATTICE. The English is by far the simpler, and it is on account of the binary divisions. I went to get a metric rule yesterday to bring down here, but I could not find in New York a metric rule which was entirely metric. This one is metric on one side and English on the other. I told them I wanted one metric on both sides, and they said they made a few a great many years ago, but found that there was no call for them. I said, "Who do you sell them to?" They said, "We export them to South American countries." But they have no call for the metric rule altogether. They have the inch on one side and the metric on the other.

Mr. GAINES. So that the metric, in this country, practically goes along with the English?

Mr. MATTICE. Yes, sir.

Mr. LILLEY. And in South America, too?

Mr. MATTICE. Yes, sir.

Mr. LILLEY. Do I understand you to say that even though we went back and started all over again that you would take the English system?

Mr. MATTICE. I would, by all means, the binary system for manufacturing.

Mr. LILLEY. For measurements?

Mr. MATTICE. For measurements for manufacturing, until you get down to very fine measurements, when you use a screw micrometer.

Mr. WEBSTER. Why not have your micrometers in the binary system?

Mr. MATTICE. Because it is more convenient to make the micrometer scale in the decimal system.

Mr. GAINES. Admiral Melville said this [reading from testimony of Rear-Admiral Melville before the committee, February 20, 1902, p. 109]:

As regards the metric system, Mr. Chairman, it is, to my idea, an ideal system for the laboratory or for the academy.

What do you say to that?

Mr. MATTICE. I say "yes."

Mr. GAINES (continuing reading):

Practically, at the present day, its adoption would cause a great deal of confusion in the naval machine shops and in naval contracts, with regard to bolts and nuts, the diameters of bolts, and all that, sort of work. It would also cause considerable confusion in our drafting rooms. In the different navy-yards of the United States I presume we have $5,000,000 worth of machinery and tools—tools of precision, with leading screws for moving the carriages, for cutting threads on bolts and nuts, and all that sort of thing. To alter those tools, I suppose it would take at least one-fourth of their value. It would take some time to do that. It need not all be done at once, but eventually it would have to come about.

What do you say to that? Is that practically correct, or technically or literally correct?

Mr. MATTICE. I think that is correct. I might explain that one reason why the carpenter prefers the inch rather than the meter in Germany is on account of the flexibility of the measurements dividing by 2. It is very much easier for him. In a great deal of his work he has to divide by 2, and it is much easier for him to divide in the English scale. Another thing is that he has a choice as to fineness of scale. He can use a sixteenth or an eighth or a quarter, as he pleases. Take this ordinary 4-foot rule, English; it is divided into sixteenths, and here is a carpenter's rule divided into sixteenths on one side and eighths on the other, and the house carpenter will use the eighth more frequently than he will the sixteenth.

Mr. LILLEY. Why does he not use the tenth or twentieth? Why could he not do it as well?

Mr. MATTICE. You can only go to a certain extent in your subdivision or your multiplying and read it quickly. If you will examine these two rules, or the two sides of that rule, you will see how much easier it is to read to the English scale, where there is a long mark for half an inch, and a shorter mark for a quarter of an inch, and shorter than that for an eighth, and shorter yet for a sixteenth inch. Men who are equally versed in mechanical work in English and metric I have found invariably will work quicker with the English. I have tried foreign draftsmen who have come over here, and those who have been accustomed to the metric system will work quicker after very little tuition in the English.

Professor NEWCOMB. You have been speaking about one-sixteenth, one-eighth, and one-quarter. I never heard of a sixteenth, eighth, or quarter recognized in any English measure whatever. So far as I know, they go by 12 inches to the foot, 3 feet to the yard, etc.

Mr. MATTICE. But that is what they are using every day, tens of thousands of people, the inch divided into quarters, eighths, sixteenths, etc.

Mr. WEBSTER. Why can you not divide a centimeter into two? Why do you keep wanting to divide by 2, by 2? Everybody has got two children; I suppose that is the reason.

Mr. MATTICE. I am trying to talk sense.

Mr. WEBSTER. So am I.

Professor NEWCOMB. You can just as well divide by two in the one system as in the other.

Mr. MATTICE. Then you get away from your decimal system.

The CHAIRMAN. I suppose the contention is that you depart from the system?

Mr. MATTICE. You depart from the system.

Mr. WEBSTER. Is your next pipe tee smaller than that half as big?

Mr. MATTICE. Yes; more than half.

Mr. WEBSTER. Of course not. Why do you keep talking about dividing by two? You seem to think that that is the only thing people want to do.

Mr. MATTICE. I am speaking of dividing by two in measurements only. There are certain reasons, which all persons of sense well understand, why you have to have measures that can be readily divided by two.

Mr. GAINES. Is there not a complexity in calculations in using the metric system that is absent in using the English system, and that is liable to bring about mistakes in calculations?

Mr. MATTICE. In using the metric system throughout I do not know of any complexity. It does not occur to me at this time.

Mr. GAINES. The reason I ask you that question is this: I was up in New York two or three weeks ago, and came across a Mr. Wood, who is an engineer, who does a great deal of work in Cuba, and so on, and who is quite familiar with both systems, the English and the metric, and works in both, and he says he prefers the English system; and one of the reasons he gives is because it is less liable to mistake, and that in using the metric system, because of the number of figures and fractions, he did make mistakes, and those he employed made mistakes, and it took a great deal of time to fish them out. What is your experience?

Mr. MATTICE. I do not remember anything of the sort.

Mr. GAINES. Do you know Mr. Wood?

Mr. MATTICE. I know several Woods, but I do not think I know the one you refer to.

I think that is all I have to say. I have to catch a train.

The CHAIRMAN. Is there anyone else here who is anxious to get out of town?

Mr. BOWERSOCK. It has been asserted before the committee that in case a gradual change was brought about by this bill the ordinary workmen, carpenters and others of that class, would be put to a large expense in making changes in their tools.

Mr. MATTICE. In their personal kit?

Mr. BOWERSOCK. Yes.

Mr. MATTICE. Yes, sir.

Mr. BOWERSOCK. Do you think there is anything in that?

Mr. MATTICE. Oh, yes, sir.

Mr. BOWERSOCK. To what extent?

Mr. MATTICE. You take a good machinist——

Mr. BOWERSOCK. No; the average workman, the carpenter.

Mr. MATTICE. The carpenter?

Mr. BOWERSOCK. Yes.

Mr. MATTICE. With the carpenter I should say it would be very little expense, indeed; just a few tools.

Mr. BOWERSOCK. How about the blacksmith?

Mr. MATTICE. It would be very little for the blacksmiths and the carpenter.

Mr. BOWERSOCK. The ordinary trades?

Mr. MATTICE. Yes; you might say the coarser trades.

Mr. BOWERSOCK. In those the expense would be very little for the change?

Mr. MATTICE. Yes, sir.

Mr. GAINES. With whom would the expense occur?

Mr. MATTICE. With the machinist and the manufacturer of machinery. When I say manufacturer I do not mean the occasional shop that turns out an odd job, but the person who is making goods in competition with the world in great quantities, the big concerns in this country, where they manufacture cheaply.

This matter of the inch goes away back. Your inch thread goes back to the stock that you make it from. You do not want to get too much stock or too scant stock and run chances. That goes through all the metal trades from the time the iron gets out of the blast furnace.

The CHAIRMAN. This bill could not possibly touch such manufactures as that?

Mr. MATTICE. Only in this way, that if the Government requires, say, a 20-millimeter bolt, it affects the man back of the bolt, who furnishes the stock for that bolt. A great deal of stuff also comes in cold rolled steel, which is used more and more every day without any finish.

The CHAIRMAN. If the Government designs a new machine, it is no longer a standard machine, and all these tools that you speak of that you use for manufacturing cheaply are out of business?

Mr. MATTICE. Yes, sir.

The CHAIRMAN. So the expense would come if the Government designed a new machine and asked the standard manufacturer to make it, whether it was designed on the metric or any other system?

Mr. MATTICE. Yes, sir; if it was entirely special.

The CHAIRMAN. And to the extent that the design was new, it would put the standard manufacturer to the same trouble, whether it was in the metric system or in any other system?

Mr. MATTICE. If it was entirely special; yes, sir.

The CHAIRMAN. And to the extent that it was special, whether designed in the metric system or designed in our system, it would put him to that same trouble. He could not use his tools for duplicating.

Mr. MATTICE. If it is entirely special. But with the metric system it probably would be more special.

The CHAIRMAN. You think the probability is more that way?

Mr. MATTICE. I say it would; and consequently it would cost the Government a great deal more for all their machinery than it does now.

The CHAIRMAN. But if the Government orders that standard machine, you would naturally use the same tools to make it that you are using now.

Mr. MATTICE. If the Government disobeyed the law.

The CHAIRMAN. How would the Government disobey the law?

Mr. MATTICE. Taking a machine made on the English system when under this bill they would be required to use the metric system.

Mr. BURLINGAME. The question was asked as to the individual loss to the workman. I have given thought to the question, and, taking the carpenters and blacksmiths, where the expense would be only a few dollars, up through the higher grades or lines it would run up to $50, $60, or $75 even for the ordinary trades for the individual workmen if they had to use the metric system.

Mr. GAINES. What is your name and occupation?

Mr. BURLINGAME. My name is L. D. Burlingame, of the Brown & Sharpe Manufacturing Company, of Providence, R. I. I represent them here to-day as opposed to this metric legislation.

Mr. GAINES. What is your business?

Mr. BURLINGAME. Chief draftsman for the Brown & Sharpe Manufacturing Company.

STATEMENT OF HENRY R. TOWNE, ESQ.

Mr. TOWNE. As I believe that you ask for "pedigrees" here, Mr. Chairman, I will state that I was educated at the University of Pennsylvania, and studied also at the Sorbonne, at Paris, where I had to use the metric system, of course. My early experience in engineering work—I am an engineer and manufacturer—included some work with William Sellers & Co., of Philadelphia, in the one department of that plant where they use the metric system. I have been for thirty years the president of the Yale & Towne Manufacturing Company. I am a past president of the American Society of Mechanical Engineers.

Originally I believed that the adoption of the metric system would be a benefit to us and should be promoted. I held that opinion for a good many years, during which I had no occasion to study the subject from a practical point of view or carefully. Accident led me to take it up seriously some years ago, and as I began to study it and to try to understand the effect of the proposed change on the country my opinion began to change, and the more I have studied the subject, Mr. Chairman, the more convinced I am that for this country to change from the English base to the metric would be a national misfortune.

With the permission of the committee, I propose to present my reasons for this opinion, and in doing so I shall endeavor to avoid repeating what I had the privilege of saying here two years ago when I appeared before this committee on the same subject.

I think, Mr. Chairman and gentlemen, that it will help us greatly to clear up this subject if we will divide it into sections. I believe that much of the confusion which exists in the minds of members of your committee, as I have followed the record of your sessions, which

I have done very closely, has arisen from the effort to discuss different phases of the subject at the same time. There are many phases, and they are confusing when you attempt to discuss several of them together, and especially when you pass rapidly from one to the other, back and forth.

One of the underlying questions, which has entered into the discussion throughout, is not fundamental to the metric system or to the English system, but it is a question of arithmetic, of notation, namely, the decimal system. We are all familiar with that from using our decimal coinage. We know that it is a great convenience and advantage in computation, and we would all like to have the same advantage extended into our weights and measures, as far as we reasonably can. The metric system is decimal from beginning to end, and in that respect has a great advantage for purposes of computation. But the decimal system is not the natural system of the human mind and therefore never will prevail in the common transactions of the everyday life of the people. The natural process is by binary division, first into halves, then into quarters, and so on. This preference is inherent in the human mind and you can not change it. As children, if we had occasion to divide an apple, we cut it into halves, and if there were more divisions required to be made we divided it into quarters and eighths, but we never thought of dividing it into tenths.

There are two things to be kept in mind in considering the question of weights and measures. First and chief should be the convenience of the common, everyday people in their everyday uses; and for that purpose the decimal system is not the best. The other thing to be kept in mind is convenience in computation; and for that purpose, all things being as they are, the decimal system is the best. The duodecimal system has advantages. A still better base than 12 would be 16, as was shown by John W. Nystrom fifty years ago. But the decimal base is too firmly established throughout the world to justify an attempt to change it. Therefore we shall wisely adopt the decimal method in any change of notation for whatever system of weights and measures we finally may adopt. But if that system can also be susceptible of binary division for the uses of the people in everyday life, we shall have something even better for such uses than the decimal system.

Mr. Gaines pointed out, during the examination of a preceding witness, that the figure 10 is divisible only into two aliquot parts (2 and 5) and that the figure 12 is divisible into four aliquot parts (2, 3, 4, and 6); 12 is also related to 60, and 60, from the time of the Chaldeans, has been the base of all astronomical work, is the unit of our time subdivisions, and is the unit for the division of the circle, which is the foundation of all geometrical work. The division into 60, for the purposes of astronomy, of geometry, and of time, and of all science which is based upon any or all of these, will never be changed.

The CHAIRMAN. That is neither decimal nor nondecimal?

Mr. TOWNE. It is duodecimal. The base is 12, and so, gentlemen, the decimal system is not universal, even in metric countries, and never can be, because it is not founded on the natural base. The human mind takes two, primarily, as the divisor when making subdivisions of any unit.

The CHAIRMAN. I would like to ask you this question, if this is a proper point: Taking any convenient unit as you will do, depending upon the work that you are trying to accomplish, what is the objection to having a decimeter or a millimeter—suppose that you are doing fine work, and the millimeter is the unit, the most convenient unit; what is the objection to halving it, or quartering it, or eighthing it, or sixteenthing it, or anything else? Why does not the binary subdivision proposition apply to any unit that you may use as the convenient unit for performing your work?

Mr. TOWNE. Then you lose at once the benefit of the decimal system.

The CHAIRMAN. Well, there is nothing sacred about that. The advocates of the decimal system do not think it is so sacred that if there is any way in which you can make it more convenient to divide a unit you are compelled to stick to your decimal subdivision simply because you advocate a decimal system.

Mr. TOWNE. And, as a matter of fact, that is done in metric countries. For example, if you buy at retail in France, by weight, they do not quote you prices per kilogram. They give you prices per "livre"—the old French word for pound; which is the half of a kilogram. The kilogram is too big for the ordinary transactions of life, and they have cut it in two, and they buy and sell by the "livre," and they subdivide that by binary division, and sell you a half livre or a quarter livre.

Mr. WEBSTER. Do they subdivide the franc into sous or centimes?

Mr. TOWNE. Into sous.

Mr. WEBSTER. That is 5 centimes?

Mr. TOWNE. It is. If a reform in notation is all that is sought by this bill there is no trouble in obtaining that. It is perfectly feasible to reorganize our present standards of weight, volume, and length, and to subdivide them decimally. There is no need to resort to the metric system merely for the decimalizing of our units. On this ground, therefore, the argument for the bill, it seems to me, is not well based.

To sum up, therefore, the effort in notation should be to find a system of subdividing our units which admits of binary division for the ordinary uses of life and which also admits of decimal division for the purposes of computation, as, for example, we now divide the inch into one-half, one-fourth, one-eighth, and one-sixteenth for common use and into one one-hundredth, one one-thousandth, and one ten-thousandth for fine work and in calculations.

The next division of the subject, in importance and in logical order, is the question of absolute units, whether of length, of weight, or of volume. The French conceived the idea, when evolving the metric system, of having an absolute base, one founded on nature, and they adopted one ten-millionth part of the earth's quadrant and thought they had determined it. It has been discovered since that their calculations were wrong and that the meter is not a definite fraction of that base.

Mr. SCROGGY. You say the French did that?

Mr. TOWNE. Yes.

Mr. SCROGGY. No other nation?

Mr. TOWNE. The other nations adopted the metric system afterwards, retaining the same base. The meter is not an exact fraction

of the earth's quadrant. But that fact is quite immaterial, and the meter is none the less an effective and, for some uses, an appropriate unit of length. Experience in both systems, however, has satisfied those who work with them, and especially those who work in the metal industries, which underlie all other industries, that the meter is not a convenient unit of length. It is too long in itself and its decimal subdivisions are either too long or too short, and that the English foot is a better unit, with its subdivision into inches, and that the inch, decimalized into hundredths and thousandths, gives better working units than the subdivisions of the meter. Either may be taken. The vital thing is to have an absolutely fixed unit, which shall serve as the base for the national measures of length; but in choosing that unit we should keep in mind the element of convenience. The meter is not convenient, and there is overwhelming testimony to this fact.

Mr. GAINES. How would you express the meter and the English inch? What is the difference between the size of the two?

Mr. TOWNE. The meter is 39.37 inches, sir.

The CHAIRMAN. The yard is more convenient than the meter?

Mr. TOWNE. They are almost alike; and if the French had only seen fit in 1790 and 1801 to add a small fraction, less than 2 per cent, to the length of the meter and make it 40 inches the metric system and the English system would have been reduced to a common base. Very infortunately that was not done.

The CHAIRMAN. Do you favor going to a duodecimal system of notation?

Mr. TOWNE. I am hardly competent to answer that question offhand. I would say that in any reconstruction of our present units of weight, volume, and length the effort should be, while preserving decimals for computation, also to bear in mind facility for binary division for common use; and if that subdivision can be on a duodecimal system it will best serve the purposes of the people. The people of all countries in the world from the beginning of civilization have used the duodecimal base largely in their calculations and in their common notation. This is seen, for example, in the division of the year into twelve months, the day and night into twelve hours each, the foot into 12 inches, the pound (Troy) into 12 ounces, etc.

All of the early units of length were based on nature. The cubit, the ell, the French aune all were supposed to be the length of the forearm. The foot, the French inch or "pouce" (the French word for thumb), and the grain are all natural units. Each country or district adopted its own units, and as commerce at that time was restricted the divergence of these units was not sensibly felt by the people using them; but as industry developed and as commerce became more and more international the want of uniformity in measures became increasingly apparent, and hence arose suggestions for a standard in each kind of measurement—of weight, of volume, and of length. This suggestion was made long before the adoption of the metric system, by France, by England, and by other countries. All recognized the desirability of something better than the confusion which then existed.

It happened that France, under Louis XVI, took the initiative, and in 1790 appointed a technical commission for the study of the subject. The commission continued its labors for eleven years before a

solution was found and agreed upon, and reported in 1801, in November of which year the metric system was officially adopted by France.

France sought at that time to divide decimally the quadrant, but found that nature forbade and that the human mind would not accept the change and has reverted to its division by 60. France sought also to supersede the duodecimal division of the year by having 10 months instead of 12, and to subdivide the months into 3 parts of 10 days each, all of which proved fantastic and impracticable and were abandoned very quickly. The base of ten does not lend itself to all purposes.

Now, gentlemen, what was the reason which led France to take up this question at that time? Modern industry had hardly begun. Modern science was in its infancy. Each of the old provinces of France had its own units of length, weight, and volume. The confusion was terrible, and the need for unity within the borders of France was obvious. The French people had a confusion, not of tongues, but of measures, and they sought unity. That was the reason for their taking up the study of this subject, and that is the explanation of the birth of the metric system. It was not to obtain decimals. It was to obtain unity. And in attaining unity they perceived the advantage of the decimal system for purposes of computation and adopted it.

The CHAIRMAN. There was a great advantage in national unity in their weights and measures?

Mr. TOWNE. Yes, sir.

The CHAIRMAN. Would there not be a corresponding advantage in international unity?

Mr. TOWNE. I am coming to that. The French overlooked the tendency of the human mind to avail of binary division, and, unfortunately, made no provision for using it, as they might have done.

Mr. BOWERSOCK. Right there—how do you explain, admitting this condition which you speak of in France in 1801, that seventy years later, with all the experience that had come during that time and the change in commercial conditions during those years, as intelligent a nation as Germany, with all the extreme racial and national prejudice between those two nations, should have adopted the metric system?

Mr. TOWNE. That is a very important question, and I was about to answer it before you stated it. In 1860 Germany appointed a technical commission to study this subject, and, as it happened, that commission took exactly the same length of time as the French commission had taken, namely, eleven years, and reported in 1871, in the midst of the Franco-German war, and on its recommendation the metric system was adopted by Germany. Exactly the same conditions which had prompted France in 1790 to take up this subject existed in Germany in 1860. Germany at that time had some forty separate States or principalities, each with its own government and nearly each of them with its own system of weights and measures, some of which still prevail, by the way. What Germany sought was unity.

Mr. SCROGGY. Would not that be desirable now among the nations of the earth?

Mr. TOWNE. That is an international question.

Mr. SCROGGY. Certainly.

Mr. TOWNE. I am addressing myself at present to the national question. But I am coming to the international question a little later.

Germany sought unity. She had then to consider whether, on the whole, it was wiser to evolve a new system of measures—and even French scientists admit that a better system than the metric could be devised now, in the light of the advancement of science and the arts in the last one hundred years—whether it would be better for Germany to devise and adopt a new and independent system or to accept the symmetrical and consistent and in many ways admirable system which France had devised and adopted, and which many other nations were using, especially having in mind the fact that France and Germany are contiguous, and that the intercourse and commerce between them was very large. Germany, as I think, wisely decided that, on the whole, the greater balance of advantages would lie in accepting the existing metric system. This decision is a tribute to the importance and immeasurable value of unity. It is not necessarily a tribute to the perfection of the metric system.

Mr. SCROGGY. Why?

Mr. TOWNE. For the reasons I have just stated, that a better system could be devised now, if the question of unity were ignored; but unity, not only national but international, is desirable, and by adopting the metric system Germany obtained both.

If we had like conditions existing in this country to-day, and I were asked to express an opinion, I would say: "By all means let us adopt the metric system." If we had the chaos which existed in France in 1790 and in Germany in 1860, then would I say that we ought to take the metric system as the best way out, on the whole, from the mire and trouble that we would be in. But what are the facts? Instead of chaos we have absolute order, absolute uniformity from one end of this land to the other, and not only that, but absolute unity (excepting in the measurements of bulk—the bushel and the gallon) with the entire English-speaking world.

The CHAIRMAN. What is the pound?

Mr. TOWNE. The English and American are identical—7,000 grains.

Mr. WEBSTER. Which pound?

Mr. TOWNE. The pound avoirdupois; but the pound troy and apothecary is based on the same grain, and can easily be brought into harmony.

The CHAIRMAN. What is the gallon in the English weight?

Mr. TOWNE. The English and American gallons are different.

The CHAIRMAN. What is the barrel?

Mr. TOWNE. That is not one of the standard measures.

The CHAIRMAN. What is the bushel?

Mr. TOWNE. That is different.

The CHAIRMAN. Will you tell me what any weight or measurement is, except the grain?

Mr. TOWNE. You mean of bulk or of weight?

The CHAIRMAN. Of bulk, or anything except length.

Mr. TOWNE. The grain is the basis of our measures of weight.

The CHAIRMAN. I have excepted that. Tell me what any other measure in our system is except the grain.

Mr. TOWNE. The inch.

The CHAIRMAN. I have excepted the inch and the grain.

Mr. TOWNE. Do you mean measures of weight?

The CHAIRMAN. Weight or volume. Tell me what any measurement is in our system except the grain.

Mr. TOWNE. Every measure of weight in the English and American system is based on the grain.

The CHAIRMAN. But tell me what any measure we have is except the grain.

Mr. TOWNE. The others are multiples of the grain. For example, the pound avoirdupois is 7,000 grains.

The CHAIRMAN. Tell me what a pound is—that is, an avoirdupois pound; the troy pound is different, and the apothecary pound is different. What is a gallon and pound and quart and bushel and barrel—anything except the grain—when you get outside of the measures of length?

Mr. TOWNE. What is a decaliter or a hectoliter? They are multiples or subdivisions of the liter. The liter is the base.

The CHAIRMAN. Is that what you understand by my question?

Mr. TOWNE. Absolutely.

The CHAIRMAN. What I mean to indicate is this: That when you get outside of the measures of length or the grain in measures of weight or mass, I do not now think of the name of any unit that has not more than one value in our system as it is generally used in the country.

Mr. TOWNE. I think I get your point now, and if so I fully agree with you, that our present system of weights and measures is cumbersome and inadequate, and can be reformed with great advantage.

The CHAIRMAN. I do not want to interrupt you too much, but I understand your contention is that we should preserve the inch?

Mr. TOWNE. That we should preserve the base. The inch is the base. That is right.

The CHAIRMAN. There is no simple and direct relation between the inch and measures of volume and weight?

Mr. TOWNE. No.

The CHAIRMAN. What objection would you have, or what would you think about the advisability of changing everything else in our system except the inch?

Mr. TOWNE. May I answer that question a little later, because it comes in pertinently with something else which I wish to say?

The CHAIRMAN. Very well.

Mr. TOWNE. I was speaking of the question of unity. We have to-day absolute unity throughout our land, and international unity with the British Empire; and also incidentally, I may mention, with commercial China, which is going to be one of the greatest markets of the world, and is to-day our greatest market for textile products. Which are the better units of length, the French or the British? Let us see. The meter has been proved, by practical experience, to be too long for most of the industries except the textile industry. A shorter unit would be more convenient in all the trades except the textile trade. The subdivision of the meter, the millimeter, is either too short or too long, and not as convenient as the decimals of the English inch. A millimeter is approximately four one-hundredths of an English inch.

As I shall show a little later, the subdivisions of the English inch (which are in practical use throughout the world, I might say) run not only to the hundredths, but to the thousandths and the ten-thousandths. I have an example here which will show that the thousandth part of an inch is a very tangible measure. The millimeter is four times too big for fine work, and if we were considering merely the question of expediency and convenience, and were selecting a standard of length untrammeled by any existing conditions, we would not choose so long a unit as the meter. As to the kilometer, the French equivalent for a mile, it may be equally convenient, but it is certainly no better. It is 0.62137 of a mile, or, conversely, 1 mile is 1.6 kilometers. There is no great inducement for us to change. One is practically as good as the other.

Again, in matters of weight, a kilogram is 2.2046 pounds, or twice as heavy, approximately, as the English pound. Experience has shown that it is not as good a unit. The French themselves do not like it. They cut it in two and call the half a "livre" and subdivide the "livre" into halves and quarters.

The CHAIRMAN. Would you take it that we do not like the pound because we sell half a pound?

Mr. TOWNE. Not at all. The unit of measurement for all transactions necessarily must be susceptible of division according to human needs. The question I am discussing is as to what the unit should be in absolute weight. The French kilogram is twice the English pound.

Mr. GAINES. It is too large for use?

Mr. TOWNE. Yes.

Mr. WEBSTER. Why is it too large?

Mr. TOWNE. Why do we want certain things in daily life, and why do we use them? What is the answer to any such question except human experience?

Mr. WEBSTER. I deny the experience. You are talking from the witness stand to support your position——

Mr. TOWNE. We have the experience of the French people themselves, who reject the kilogram and prefer to use its half and to call it by another name.

Mr. WEBSTER. Because they do not want to carry home two pounds of butter. They are very economical people——

The CHAIRMAN. I think we shall have to let the witness proceed.

Mr. SCROGGY. How long are these debates to be continued?

The CHAIRMAN. Four hours on each side, during the two days.

Mr. SCROGGY. Is there no limit to each discussion?

The CHAIRMAN. Mr. Towne will recognize that we have a limit on each side.

Mr. GAINES. I think the witness has thrown impartial light on both sides of this question, and I think he should go to the end of his statement.

Mr. TOWNE. Again, the French gram, which is the basis of all fine work in weight, is 15.432 grains—over 15 times as heavy as the English grain, and not as convenient or suitable for fine work. The grain is probably a better subdivision or unit for fine work than the gram.

When we come to large measures of weight, the French ton is 1.016 English tons of 2,240 pounds—exactly, it is 2,204 pounds. In

other words, the metric people and English people have agreed on almost an identical unit for their larger weights.

When we come to the question of volume or capacity, the liter is about one-quarter of our gallon; accurately, it is 0.2642 gallon. That makes it almost identical with our quart. Practically, the quart may be taken as the base for our liquid measures and measures of volume; and if so, it is in close accord with the metric base, and here, again, there is no material difference, no advantage or disadvantage in changing from one to the other, so far as absolute units are concerned.

In areas the French base is the hectare, which is 2.471 English acres. That is much too large, as I think all who have had anything to do with the holding of land will agree.

In dry measure the French base is the hectoliter, which is 2.8375 bushels. Here again I think all will agree that the unit is too large, although its subdivision decimally produces a unit not very different from ours, one-tenth of the hectoliter being 0.28 bushel, or a peck and an eighth, about. Our unit is probably better than theirs; certainly it is as good; and there is no inducement to change because of convenience one way or the other.

It seems to me that we may fairly sum up that, so far as convenience is concerned, the balance of argument is slightly in favor of the English units rather than the metric units, and that from this point of view there is no sufficient reason for us to revolutionize our measures in order to accept the metric system.

I admit unreservedly that in the interrelations between the measures of weight, length, and volume the metric system is far better than ours and is almost ideally perfect, because the measures of each kind are based upon the others, all primarily on the measure of length, and that this interrelation gives facility in all computations in conversion from one to the other, which is of great use and convenience in matters of computation, although useless and practically unknown in the transactions of daily life. The argument here is for the convenience of scientists, not of the people. But in considering any change in our measures we should aim primarily to make them convenient and available for common use, and, secondly, to have them facilitate the work of computation so far as possible consistently with the first requirement.

The CHAIRMAN. On this question of relation between units of length, weight, and volume, do you not think that that is a very important matter, in this: For instance, you take a tenth of a meter, cube it and you have the liter. Fill it with water and weigh it and you have the kilogram. Do you not think that with this simple relation between the units of length, volume, and weight, when you speak of a unit of length you can immediately and by a very simple process associate that with the volume and with the weight, and that the tendency of that is to give one a clearer and more distinct conception and idea of matters involving length, volume, and weight than as though it were not a system and this simple and easy relation did not exist?

Mr. TOWNE. For every purpose of scientific work, yes.

The CHAIRMAN. If so for scientific work, why not for all kinds and classes of work?

Mr. TOWNE. For the daily uses of the common people, absolutely no. They know and care nothing about this interrelation.

The CHAIRMAN. If that applies to one man who thinks, why would it not apply to another man who thinks?

Mr. TOWNE. The man who thinks, in the sense that you mean, Mr. Chairman, does it in his scientific work; but when he goes out to buy a pound of butter or a ton of coal he does not think anything about specific gravity and relative densities, or anything of that kind.

The CHAIRMAN. Suppose he is thinking on the capacity of a tank, or the amount of excavation anywhere, do you not think that same thing would apply?

Mr. TOWNE. No, sir; to a very limited degree. Somewhat, I admit; but to a limited degree. In scientific work it would apply absolutely—everything that you say. I admit beyond question that for purely scientific work the metric system has unquestionable advantages.

Mr. SCROGGY. You would legislate for the uneducated rather than for the educated people?

Mr. TOWNE. Every time, first. I would legislate for both, but give prior consideration to the needs of the people—the majority.

Mr. SCROGGY. Not for the young people, but for the old people?

Mr. TOWNE. The young people and the old people.

The utter failure to realize what the change of absolute units would mean is indicated by Mr. Littauer, the author of the bill, who said in his testimony on March 22, 1905: "Of our 80,000,000 people, 70,000,000 would learn such metric measures as they would need probably within a day or two." [Laughter.] That is pure empiricism. Such testimony should have no weight in your minds. On the other side, Maj. F. A. Mahan, of the United States Army, an ardent prometric advocate, admits that although he has employed the metric system largely for thirty years, he has always experienced great difficulty in thinking in that system, and has had to translate. There you have experience versus theory!

The next division of this subject which seems to be logically in order is the question of the measures of length. The bill proposes to change all of our measures—of length, of bulk, and of weight. As to those of bulk or volume and of weight, an argument can be made in favor of the change. I myself would urge a change which would bring our units of volume and those of Great Britain into harmony. I hope that this will be done by international action sometime. But the question of a change in the unit of length is another matter altogether, and this is where most of the confusion has arisen in the discussions before your committee. Your witnesses come here and are asked questions, and answer them honestly, but in doing so they often confuse the measures of weight and volume with the measures of length.

Mr. LOVERING. In bringing about this corelation between the English and our own system in matters of volume would you adopt the English system or ours?

Mr. TOWNE. I would refer the whole subject to a commission of technical experts for study, investigation, and report.

Mr. LOVERING. Would you not prefer our own to theirs?

Mr. TOWNE. I see no inherent advantage in ours or theirs. What we want is unity.

The CHAIRMAN. You would want such a change as would establish a simple relation between units of length, weight, and volume?

Mr. TOWNE. Yes. If we change our units of weight and our units of volume, which I believe we can do wisely, then, in that change let us see to two things—the interrelation which you speak of between the three measures of length, weight, and volume, and also unity throughout the English-speaking world. Measures of weight and of capacity or volume relate chiefly to matters which are commercial and transient. They enter also into scientific work, necessarily, but their chief importance to the people is in the commercial transactions of the world, chiefly the transactions of to-day and to-morrow. The transactions of the past which relate to weight and capacity disappear very quickly. A man's sales books or ledgers of last year do not interest him very much, and those of ten years ago do not interest him at all. The measures of length, however, relate not only to the present and to the future, but vastly more to the past. And the past, gentlemen, is closed, is gone, and can not be changed. Our units of length are founded way down deep in the past, and you can not change them by legislation. They are there, and they are there to stay.

You will all admit that there are some measures of length, and with length goes area, of course, which even you who favor the proposed bill would not change.

The CHAIRMAN. I understand that in Mexico they had no difficulty in changing their system in a very few years. I was down there not very long ago and found that they spoke of hectares just as they used to measure in barras, and universally they told me that their land was measured in hectares. The Government adopted it, and there was no trouble in the change at all.

Mr. TOWNE. You can force the Government to do anything by legislation. It is with the people that the difficulty will come.

Mr. GAINES. That would not work so well here, for this reason: Down in Mexico they are very, very slow to act. As you get into the hot climate they act slowly, eat slowly, work slowly, and have a slow way of transacting business. They have few sales, and can do thus and so. But up here, where we do the Yankee thing, quickly and scientifically, I should imagine it would run very counter to the wishes of the people.

Mr. SCROGGY. There are other speakers who wish to be heard, Mr. Chairman.

The CHAIRMAN. I would suggest to Mr. Towne that as there are a number here, unless they have some arrangement among themselves, he had better be as brief as convenient.

Mr. TOWNE. I will stop at any time.

Mr. BOWERSOCK. I want Mr. Towne to have time to get through.

Mr. GAINES. It is the most interesting statement that has been made before the committee, absolutely, and it is impartial, too.

Mr. TOWNE. I have taken considerable pains to prepare myself for the discussion, and I shall try to state the facts as briefly as possible to do justice to them.

The CHAIRMAN. There are but four hours allowed on a side.

Mr. TOWNE. If the other gentlemen wish me to stop, I will do so.

There are some measures of length and of area which I think you will agree can not be changed quickly, and some not at all. Land

areas are one class. The former bill excepted land areas from its operations. This bill does not. This is a very radical question. The existing units of length would continue to exist indefinitely in the future in all of our existing structures and machines and railroad equipment, in all interchangeable parts, especially screws, piping, couplings, and in all the existing vast equipment of special tools and gauges, as I shall illustrate very briefly.

To change the money unit of a country is not a very serious proposition. It would involve temporary inconvenience only. This has often been done. To change the units of weight and of volume is also possible and feasible. But the unit of length, as I have pointed out, is so deeply rooted in the past that to change it would be not merely revolutionary, but destructive.

I must take a little time to dwell on this point, because to my mind it presents the most insuperable difficulty and the most strenuous argument against the change which is proposed. This change in the unit of length would disorganize all of our vast mechanical industries, all of our technical science.

The CHAIRMAN. I want to make a suggestion there. I think that it will be in line with what the committee desires. I would like to have you keep this bill in mind.

Mr. TOWNE. I do, sir. I am coming directly to that.

The CHAIRMAN. All right.

Mr. TOWNE. I keep in mind also that the author of the bill himself in this room has stated that it is intended to be the entering wedge for the ultimate adoption of the metric system by the American people.

The CHAIRMAN. But not by Congress.

Mr. TOWNE. In the hope that the people ultimately will accept legislation by Congress making the use of the metric system compulsory on the people, and not merely on the Government.

The CHAIRMAN. My impression has been, and I think it is the general impression, that, so far as Congress is concerned, this is the extent to which Congress can go in a compulsory way: It can provide that its Departments must use the metric weights and measures, but not that the people generally shall use any particular kinds of weights and measures.

Mr. GAINES. But it can say that everyone who deals with the Government in weights and measures must use the metric weights and measures in Government contracts?

Mr. TOWNE. Yes.

Mr. GAINES. And that means untold millions and hundreds of thousands of dollars.

Mr. TOWNE. Who is urging this change? It is chiefly the scientists, and they are absolutely right about it. The metric system is better for their work than the English system; they are using it to-day, and they are free to use it as much as they please. We make no objection to that. But the manufacturers of the country are not urging this change. Very few of them realize what is going on in your committee room, or they would be more alive and active in expressing their dissent from this proposition.

Mr. DRESSER. They have been pretty lively. [Laughter.]

Mr. TOWNE. There is not one in a hundred of them who knows anything about what is going on here.

Since 1866 the use of the metric system in this country has been legal, and our friends on the other side are at liberty to use it, and we make no protest against their doing so. We have let them alone. Now, we ask them to let us alone.

Mr. Littauer said, among other things: "In my little factory I have six less clerks as a result of using the metric system." His business is the making of gloves. If that is true, as to cause and effect, why do not all the glove makers and others adopt this system and drop that proportion of people out of their factories? Is it not a case of non sequitur? It is argumentative, but not logic.

The transition from one system to another when France made it was comparatively easy, and the change was so greatly for the better that it was accepted gladly and without protest, although slowly. Modern industry was not then born, in the sense in which we understand the term to-day, and therefore the change from the old system to the new, even if the old system had been a good one instead of the chaos which it was, involved no insuperable difficulties. The same was virtually true in Germany in 1871. Although industry had commenced on modern lines, it had not progressed very far.

The CHAIRMAN. I think we are familiar with that part of the proposition, Mr. Towne.

Mr. TOWNE. But in France, one hundred years after the introduction of the metric system, and in Germany, nearly forty years after its introduction, the old units of length still persist. For example, as I mentioned in discussing a question with one of the other witnesses an hour ago, the Rhenish foot is still so largely used in all western Prussia that if you ask a dealer for an ordinary meter rule he will always ask you in turn—and I speak from personal experience—what kind of foot you want on the other side. They have to-day three different feet, or "foots," in use in that part of Germany, to such an extent that every hardware shop, or place where they sell implements for workmen, carries meter rules with meters on one side, and on the other side one of three different kinds of feet. You have to designate the kind you want, whether English, Rhenish, or Saxon.

The CHAIRMAN. They should unify their weights and measures.

Mr. TOWNE. They tried to do it forty years ago, and they have not gotten through with the process yet.

Mr. GAINES. Here is one of those rules that was just handed me by a man who will be a witness a little later.

Mr. TOWNE. I have a better one than that in my pocket. [Laughter.]

Mr. GAINES. It seems to me that you have a little better of everything than anybody else. [Laughter.]

Mr. TOWNE. Mr. Henry Hess, superintendent of the German Niles Tool Works in Berlin, stated in 1902 that the Rhenish inch is almost universally used in the building trades, and the English inch also, confirming what I have just stated. In English-speaking countries there is more capital invested in manufacturing based on English units of length than that in all the metric countries based on the metric system. I will give you the figures to prove this later.

As to weight and volume the change is possible, but not as to length. There have been many polls and votes of organizations, commercial, business, and scientific, and if any weight is attached

to these by your committee, I call attention to the fact that the voting includes but few manufacturing organizations—only a sprinkling of them—but so far as it goes, those who are on record as in favor of the change, chiefly commercial and scientific bodies, number 14, and those who are against the change number 44.

The CHAIRMAN. How do count the National Manufacturers' Association? They have resolved both ways. Anyhow, they have resolved in favor of it.

Mr. TOWNE. Then they would count on both sides. I do not attach much consequence to expressions of that kind.

Mr. CUSHING. I am the secretary of the National Association of Manufacturers. We had a ballot some two years ago, and voted four to one against the compulsory adoption of the metric system.

The CHAIRMAN. You voted on a different proposition?

Mr. CUSHING. No, sir; we voted on the bill that was before this committee two years ago. You are referring, I think, to a ballot taken five or six years ago, and that was against the metric system. I have a record of all this in my pocket, and I would like to file it with the committee for printing in the record, in order to remove, once for all, any doubt as to where the National Association of Manufacturers stands. It is against this proposition.

The CHAIRMAN. We will hear you later.

Mr. TOWNE. To sum up on the question of the unit of length: Any fixed unit will do. The one thing essential is to have it fixed. Some units are more convenient than others, but either will suffice, so long as it is fixed. The English inch is fixed in this country, and the effort to change it will produce vast disturbance, trouble, and expense.

Experience in other countries shows that, even under the much more favoring conditions that existed then and there for the change, one hundred years has not sufficed to make the change complete. Starting from present conditions, which vastly increase the difficulty, one hundred years would not begin to see the change completed in this country.

Land areas you could never change, and the same is true as to screws. To-day the metric countries are using the English or Whitworth screw, and the screw determines the length of every measurement in the metal-working trades. The one thing that the industries of the countries that use measures of length need is to have those measures fixed—that is, to have peace.

The CHAIRMAN. I have a statement here of Dr. Oskar Knoevenagel, said to be a large manufacturer in Germany. I quote from a letter of Prof. Karl E. Guthe, of the State University of Iowa, and in this letter he incorporates this as a quotation from Doctor Knoevenagel. He says: "In our iron industry we measure exclusively according to the metric system."

Mr. TOWNE. Mr. Chairman, the next subdivision of the subject which I am going to ask permission to speak of is what you refer to—uniformity. That is the great desideratum in measurements of length. We would like to have uniformity in all measures, and we ought to if we can. No other country has it to-day, and no country has ever had it, except the United States and Great Britain. We have uniformity throughout this land. You ask us to discard it and to substitute confusion. We ask you to desist.

We have to-day, barring the measures of volume, absolute uniformity throughout the United States and the entire British Empire, throughout commercial China, and largely throughout Russia, whereas in all of the so-called metric countries the old units still persist, and in most of them the measures used by the people are not metric at all. They are in France, they are in Germany, they are in many of the Latin countries, but not in all. But in others (Greece, for example) that have taken up the metric system the units used by the people are not metric. The old units persist. You can not legislate what people shall do in the petty dealings of their daily life and with each other. They will use what they find most convenient and what they are familiar with.

If we adopt the metric system, even for Government use only, we thereby destroy our present unity and substitute confusion. We would have the people of this country talking one language and the Government of the people talking another language in things that vitally concern both.

The CHAIRMAN. They tell us that a very large proportion of our imports come in invoiced in metric weights and measures.

Mr. TOWNE. I am coming to that.

The CHAIRMAN. You are aware that some of the divisions of some of our Departments use the metric system exclusively?

Mr. TOWNE. Yes, sir.

The CHAIRMAN. So that we have to talk it in some degree.

Mr. TOWNE. They are using it under the permissive law of 1866, which we think is all right.

The CHAIRMAN. If they use it, it necessitates their talking the language?

Mr. TOWNE. Not to our people. They talk it to the people in other lands with whom we want to do certain kinds of business that is more easily transacted in the metric language than in the English.

Mr. GAINES. And they talk it to themselves in the departments where they make up these things. [Laughter.]

Mr. TOWNE. Let us look at some facts as to this question of uniformity: The population of the United States, in round figures, is 82,000,000; of Great Britain, 43,000,000; the British Colonies, 24,000,000; total, 150,000,000 English-speaking people; and their manufactures, according to the latest available figures (giving none for the British colonies), were $11,012,000,000. I do not include in the British population the 295,000,000 people of India. France and Germany combined have 95,000,000 of people and $5,197,000,000 of manufactures. The per capita value of total manufactures in the English-speaking countries is $73 and in France and Germany is only $54. If we take all of the properly so-called metric countries—Austria, Italy, Belgium, Scandinavia, Holland, and Switzerland—and add them in, we get a total population of 203,000,000 as against our British and American 150,000,000, and a total of manufactures of almost identically the same amount—$11,000,000,000 per annum.

In other words, when we come to the question of uniformity and take the industrial nations of the world we find the English-speaking race equals all the others that I have named in the value of their total manufactures. The English-speaking people are the great manufacturing race of the world, and yet it is proposed to change the

unit on which our manufacturing industries are based for that of the other part of the world.

The CHAIRMAN. Is that proposition going on anywhere else? Is not that same proposition pending in England?

Mr. TOWNE. In the same sense that it is pending here.

Mr. GAINES. And has been for a great many years, and they are still in the same fix we are in.

The CHAIRMAN. Is it not pending in Canada and in Australia and anywhere and everywhere where they do not have a decimal system?

Mr. TOWNE. It has been pending in England for over one hundred and thirty years and is still pending.

The CHAIRMAN. I see by the late consular reports that Canada has just, at public expense, employed lecturers to go around and educate people in the metric system.

Mr. GAINES. We employed John Quincy Adams in Congress to do that over one hundred years ago.

Mr. SCROGGY. And he was a pretty good man.

Mr. GAINES. But he recommended against it. [Laughter.]

The CHAIRMAN. His conclusion was that it was not wise to adopt it then and that we had better wait to see it perfected. He was very sensible.

Mr. GAINES. Napoleon and Gladstone sat down on it, too.

Mr. TOWNE. The adoption of the metric system by other countries is not an inherent proof of its soundness. In this respect I think you have been misled, unintentionally, by the testimony of your witnesses. The real and chief motive which led to the adoption of the metric system, in every country that has adopted it, was the desire for uniformity. That was the great inducement, the desire for uniformity, first national and next international.

The CHAIRMAN. I was going to ask where that proposition for uniformity would end.

Mr. TOWNE. I appreciate the point of your question, and I will answer it in this way: The primary motive was to have unity within the nation in place of the confusion or chaos which existed before. Having attained to that degree of enlightenment on the subject, they appreciated that it would be also desirable and convenient to have international unity; and as other nations seeking national unity took up this subject after France had adopted the metric system, they wisely conformed to the French system. But we have no such condition confronting us. We have to-day absolute national uniformity. We have no internal reason for change. We have not external reason for change so far as relates to the vast English-speaking part of the world, except as to measures of volume.

The CHAIRMAN. I understand you to say that there is no argument in favor of our changing to the metric system?

Mr. TOWNE. Not on any internal ground.

The CHAIRMAN. Oh!

Mr. TOWNE. The argument to change, briefly stated, is that for the sake of getting international unity we shall sacrifice national unity and accept internal and national confusion.

Mr. SCROGGY. That would not accord with Doctor Bell's argument.

Mr. TOWNE. I speak from the point of view of a manufacturer and engineer and mechanic. The scientists are at liberty now to use the metric system, and are doing so.

Mr. LOVERING. Did not this spring entirely from the scientists—the original idea?

Mr. TOWNE. Of the metric system?

Mr. LOVERING. Yes.

Mr. TOWNE. It sprang from France's desire to have uniformity, and from her wisdom in deciding that, before adopting any new measures in place of her old ones, she would refer the whole subject to a competent body of technical experts, which she did. That body was a very large one, with some of the most distinguished scientific men of that day in it, and it labored eleven years before making its report.

Mr. GAINES. About that time France was not much disposed to adopt English customs?

Mr. TOWNE. No; but she invited England to come into the conference, and, as a matter of fact, five other nations participated in the membership of the French commission which evolved the metric system. All nations were invited, and five nations responded; they accepted appointments, and their representatives served on the commission. England was invited, too, but naturally, at that time, she did not accept.

Therefore, on the ground of seeking uniformity, neither the United States nor the British Empire has any reason to change, so far as concerns internal conditions or international conditions between themselves.

It is alleged that out of thirty-nine civilized nations—and this is in evidence before you—thirty-six have adopted the metric system, Investigation will convince you that most of those thirty-six has adopted it only as you propose to adopt it here, for Government use, and that the people are not using it exclusively nor even extensively. But the other three who are excepted from the thirty-nine are Great Britain, Russia, and the United States. The population of those three is 567,000,000, and of all the other thirty-six put together is only 445,000,000. So that if you come down to the question of the extent of population that is to be reached by this proposed change—that is, to the weight of numbers—the advantage lies rather with us than with the other side. Certainly there is no preponderance which would justify such a revolutionary change as you are considering.

The CHAIRMAN. However, it is the metric system against the field; is not that about it?

Mr. TOWNE. Or the English system. The English system to-day is in use by more people than the metric, and to a vastly larger extent in manufacturing. It is a struggle between two systems as to which shall survive, if one must go under, or, as I believe personally, it is a question now as to how the English system of measures shall be reformed and modernized and to some extent—to the greatest extent feasible—be brought into harmony with the metric system.

The CHAIRMAN. It is the new against the old; is not that about it?

Mr. TOWNE. I should not state it so. [Laughter.]

Measured by colonizing and assimilating power, and this has reference to our foreign trade, the English-speaking races, as we all know, are the great colonizers of the world. All the other races together do not begin to count as against what Great Britain has done in the colonizing of foreign lands; and every one of those lands is an open market to us. We are going into the colonizing business

a little ourselves just now, and every step in that direction means a broadening of the markets into which the English measures are carried by the English or American people as they go, and in which they will prevail until legislation changes them, if ever.

The CHAIRMAN. And in our colonizing we legislate, as you know, in the metric system now.

Mr. TOWNE. For the Philippine government, yes; but not for the Philippine people. They are not using the metric system.

Mr. DRESSER. What system are they using?

Mr. TOWNE. A conglomeration of old Spanish weights and measures.

The CHAIRMAN. The official system is the metric?

Mr. TOWNE. Yes, sir.

So, gentlemen, on this vital question underlying the whole subject which you are considering—namely, the question of uniformity—I repeat that we have uniformity to-day in this land of ours as no other land, barring Great Britain, ever had it before; and we have international unity with the British Empire, and the two together outnumber in importance all the rest of the world for industrial and commercial purposes. In addition, we have in the English standard the accepted commercial standard of the Chinese Empire, with all its vast possibilities, and largely of Russia, the two together representing an enormous aggregate of population.

The CHAIRMAN. The metric system has gone around the world, and admittedly a large number of people use it; a large amount of manufacturing is done in it, if the statement we get is true that 75 per cent of our imports come in invoiced in metric weights and measures. If that is so, somebody somewhere must use it. What is the tendency on the part of the world, to go to the decimal system or otherwise, in your judgment?

Mr. TOWNE. Distinctly toward the decimal for work involving computation. Absolutely not so for the uses of daily life. No people that I have ever visited, and I have traveled pretty extensively, use the decimal system and reject the binary system for their ordinary transactions.

The CHAIRMAN. You would say commercially the decimal system is greatly on the increase?

Mr. TOWNE. Yes, sir.

The CHAIRMAN. Do you not think that commercially a decimal system will become universal?

Mr. TOWNE. For what? For all measures?

The CHAIRMAN. I said commercially.

Mr. TOWNE. For all measures or for coinage?

The CHAIRMAN. I said commercially.

Mr. TOWNE. Money?

The CHAIRMAN. For commerce.

Mr. TOWNE. Money is a matter of commerce.

The CHAIRMAN. I presume it is a part of commerce.

Mr. TOWNE. I think undoubtedly a decimal system of coinage will ultimately prevail everywhere.

The CHAIRMAN. I did not say a decimal system of coinage. I say do you not think that commercially a decimal system will become universal?

Mr. TOWNE. For purposes of computation; yes.

The CHAIRMAN. Well, for purposes of barter and trade?

Mr. TOWNE. No; absolutely.

Mr. GAINES. Because you get down among the people, then?

Mr. TOWNE. When you ask a savage, or a boy, or the most highly civilized man to divide an apple, he is not going to divide it into one-hundredths, giving you fifty and taking the other fifty. He will cut it in two. He will not use the decimal system.

The CHAIRMAN. I do not want you to understand me to mean that we will never quarter and halve things. I ask whether you think it is possible that we shall have commercially a decimal system of weights and measures?

Mr. TOWNE. That is, universally throughout the world?

The CHAIRMAN. I do not mean in its literal sense. Do you believe it is possible to have a universal system of weights and measures, generally speaking?

Mr. TOWNE. No, sir; but I think we shall get pretty near to it.

The CHAIRMAN. What will that system be?

Mr. TOWNE. I believe the English-speaking races, and others that may affiliate with them commercially, China and Russia, for example, will sooner or later—and this committee could do no better work for the world than to initiate the movement—reform the English scales without changing the English units; that when this is done the English system will endure for all time; and that when this is done the British or English system will largely be brought into harmony with the metric system. In all other countries where we have no affiliation, national or commercial, with Great Britain or America, I believe that the metric system ultimately will prevail.

The CHAIRMAN. Do you know of any nation that has changed its weights or measures during the last one hundred years that has changed to anything else but the decimal system?

Mr. TOWNE. I do not.

The CHAIRMAN. Do you know of any nation anywhere having a decimal system where a proposition to change it to one nondecimal would be tolerated for a moment?

Mr. TOWNE. No, sir; and I should oppose that.

The CHAIRMAN. Do you know of a nation anywhere not having a decimal system of weights and measures where there is not a constant agitation and strife for a decimal system?

Mr. TOWNE. I am afraid I am not competent to answer that question, because the countries which have made the change to the metric system did it primarily to get uniformity, in place of confusion. Having that need, they wisely took the metric system.

Mr. SCROGGY. Is not uniformity the thing desired by the people of the United States?

Mr. TOWNE. It is; and we have it to-day.

Mr. GAINES. I want to read this, from John Quincy Adams:

> In relation to weights and measures throughout the Union we possess already so near an approximation to uniformity of law that little more is required of Congress for fixing the standard than to provide for the uniformity of fact by procuring and distributing to the executives of the States and Territories positive national standards conformable to the law.

Mr. TOWNE. In other words, insure uniformity.

Mr. GAINES. We had it then, and we have it now. That is John Quincy Adams's report.

Mr. SCROGGY. What is the objection to the bill?

Mr. TOWNE. That bill would destroy uniformity and substitute confusion.

The CHAIRMAN. This bill applies to the Government of the United States. You say we have uniformity in the Government service?

Mr. TOWNE. Substantial uniformity.

The CHAIRMAN. I understand that down at the Philadelphia mint they use the apothecary's weight for their drugs and chemicals; they use the avoirdupois for their coarse material; they use the troy weight for their precious metals, and they manufacture our subsidiary silver in grams. Do you think there is uniformity in weights and measures there?

Mr. TOWNE. Excepting the last mentioned, it is all uniform. They are all English units. The units may be inconvenient and clumsy, but they are all established units.

The CHAIRMAN. We all agree that we legislate in metric units. I was in the Ways and Means committee room the other day and I noticed a bill for the manufacture of wine expressing some of its volumes in metric terms. I understand that in all the Departments of our Government we use the metric system more or less, and that in some divisions we use it exclusively.

Mr. GAINES. What divisions?

The CHAIRMAN. In the Marine-Hospital Service and in the army and navy medical service they use it exclusively, as I understand. It has been repeated to us so often that I can state it again, that a large part of our imports come in invoiced in metric weights and measures, and a considerable portion of our exports go out in metric invoices. Do you say that we have uniformity there?

Mr. TOWNE. I say we have far more uniformity to-day than we would have if we passed this bill.

The CHAIRMAN. Oh, well, I understood you to say that we had perfect uniformity.

Mr. TOWNE. Among the people we have, absolutely. It is only with the Government that there is a departure from it.

Mr. GAINES. Do you remember Admiral Melville's testimony? He said that the metric system would produce great confusion in the Government service—navy work.

Mr. SCROGGY. Why?

Mr. GAINES. Here is his testimony, a whole page of it, and I will read it to you if——

Mr. SCROGGY. No, no. [Laughter.]

Mr. GAINES. He said that practically at the present day its adoption would cause a great deal of confusion in the naval machine shops and in naval contracts, with regard to bolts and nuts, the diameters of bolts, and all that sort of work.

Mr. TOWNE. May I answer that question by asking one? If the gentleman opposite you [Mr. Scroggy] should happen to be a landowner and perhaps be buying some additional land, and should ask what the area of the land is, and was told that it was sixteen hectares and a quarter, I am afraid that he would be a little puzzled to know how much money he would like to part with in exchange for that land.

Mr. SCROGGY. If I had any sense I would employ a lawyer.

Mr. TOWNE. That is what we would all have to do if we had the metric system. [Laughter.]

Mr. GAINES. And you would have to get a Philadelphia lawyer to explain it. [Laughter.]

Mr. SCROGGY. A good many think that that is what we would get rid of by adopting the metric system.

Mr. TOWNE. The question is asked, of course, what influence would the proposed change have on our domestic commerce and industry. The great difficulty would be to effect the transition, as I have pointed out. We might accept the metric system in place of our present system if there was any way to bridge over the gap, and to substitute, in the minds and memories of our people the one instead of the other; but there is no such bridge, and the effort to make the change would mean confusion for a hundred years and longer. People think in their familiar units, and can not translate mentally into new ones.

The metric units are no better than ours; they are inferior in some respects. The use of the metric system was legalized in 1866. Why should we do anything more? Are we to undertake paternal government in such a matter, and say to the people, who are free to-day to use the metric system: "That is not sufficient. You must use it. We know better than you what is good for you. You must cease the use of your old measures and adopt the new?" And yet Mr. Littauer himself admits that that is the ultimate purpose sought in this bill. Certainly no such revolutionary programme as this implies, in its effect upon our domestic industries, should be contemplated except in response to a great and overwhelming public demand. I ask, does any such demand exist? Have you had any evidence of any such demand put before this committee?

Mr. LILLEY. I have one letter favoring it, out of several hundred.

Mr. GAINES. Two or three professors have asked me to vote for it.

Mr. TOWNE. The scientists want it; so do the chemists; and they are using it to-day. The opticians and the electricians are using it to a certain extent, because electricity is a modern science, and——

The CHAIRMAN. Do you think that one system differing widely from our own can be used in the electrical industry, involving billions of dollars and billions of horsepower in machinery, and as much in the chemical and the other industries—do you think that you can have all that going on in one system, and yet have this perfect uniformity that you have been talking about?

Mr. TOWNE. No; I do not; but where the departure from uniformity occurs, it is voluntary and for good reason. The electrical industry uses metric units——

The CHAIRMAN. In other words, the metric system is working its way in?

Mr. TOWNE. No, sir; the other system has never been in, because the electrical art has been born in such recent years, and so largely in countries using metric measures, that it compels the initiation of new units that never existed before; and we all concede that if we are to have a new unit like the ohm, the ampere, or the volt, we should have them on the metric basis and not on the English basis. That is the case of where there is a new unit to be created, which is a very different proposition from substituting new units for old ones. If there is such great benefit to be gained, even in the electrical in-

dustry, by adopting the metric system, why does not the Westinghouse company, or the General Electric Company, or any of the other great electrical industries, switch over to the metric system for their mechanical work as well as for their electrical work? But they are not doing this, and although they are doing business all over the world, they adhere, in all of their mechanical work, to the English inch as the basic unit for their measurements.

If we should make the change, I want to point out what its effect would be on some of our domestic transactions. We would still have the old sizes of things. They can not be changed for a long time, but we would have to call those old sizes by their new names. A mile would cease to be 1 mile, and would be 1.6 kilometers. A pound would no longer be a pound; it would be 0.45359 kilogram; a quart would be 0.94636 liter, and so on. I could go on and say, if I wished to be extreme, that a 2-cent postage stamp would take 5 decimals of a franc to express it.

The CHAIRMAN. Take the metric terms in even size and express their quantities in decimals.

Mr. TOWNE. But you can not change the existing sizes of things. You can call them by a new scale, a new name, but you can not change the sizes—not for generations.

The CHAIRMAN. Take any article in this room. Take that door, or that desk, or this table, or take that chair.

Mr. TOWNE. That is right.

The CHAIRMAN. I can measure any one of those articles.

Mr. TOWNE. Just as well by one as by the other.

The CHAIRMAN. In even metric units as nearly, and a good deal more nearly, than you can with our ordinary English ones.

Mr. TOWNE. I think you are mistaken.

The CHAIRMAN. I have tried it, and I think I can do it.

Mr. TOWNE. I would simply ask you, then, if this door is 36 inches wide, how wide is it in metric measure? That is a very simple question.[a]

The CHAIRMAN. It stands to reason that you can do it, unless you adopt something less than an eighth of an inch. A millimeter is a twenty-fifth, and the chances are that there is no such accuracy in the manufacture or measurement of any one of the articles I have named that you can not measure it more nearly in even metric units than you could in English units.

Mr. TOWNE. Say we make an error of one-eighth of an inch in measuring this pair of doors. That means a crack where they come together, and the joints are no longer tight.

The CHAIRMAN. Give us the width of that door.

Mr. TOWNE. In English measure?

The CHAIRMAN. Yes, sir. Never mind, though; we had better not stop for that.

Mr. TOWNE. Land areas, I think you will agree, can never be changed. We have our old deeds and records, and they will stand. Screw threads, speaking as an expert, I tell you also can not be changed, and they are the basis on which every measurement of the metal-working trades is built up. Mr. Swasey, of Warner & Swasey, informed me only lately that during the last ten years he has shipped

[a] 36 inches is equal to 0.9144 meter.

perhaps half a million dollars' worth of screw machines into Germany, and, without exception, every one of those machines was fitted for fine work in the reproduction of other tools with the Whitworth screw, which is the English standard. And even the machines which he has sent into France itself were many of them fitted with the Whitworth screw. Yet France adopted the metric system in 1801.

The CHAIRMAN. There are three or four systems of screws—the National, the Whitworth—and they have a metric system, I suppose?

Mr. TOWNE. They have tried to, but it has not become established.

Just two minutes more to repeat something which I stated at greater length when I was here two years ago, as to what measurement means to the mechanic. Here are a few gauges which are used in my own business, and there are millions and millions of dollars' worth of such gauges scattered through the workshops of the country. Here is one pair of gauges to caliper 1 inch in diameter. This is the male and this the female gauge [exhibiting gauges to the committee.] This pair has probably cost, at a guess, $15; but made one at a time, as we have to make them for special work, they cost more. In using these, gentlemen, so great is the necessity and desire for the maintenance of the standard—and you are proposing to "monkey" with our standard—that we do not put this gauge into the shop for the workmen to use, but we keep it locked up in the safe and give him a duplicate; and every little while an inspector brings his duplicate back to where the standard is kept to see how much it has worn, and if the wear is sensible the gauge is readjusted or discarded.

The CHAIRMAN. Would the adoption of this bill cause anybody to change the gauge?

Mr. TOWNE. Absolutely, in time.

The CHAIRMAN. How and why?

Mr. TOWNE. For this reason: At present 1 inch is the unit——

Mr. GAINES. What is that gauge that you have in your hand? Describe it.

Mr. TOWNE. This is a ring gauge. It is a steel disk, about 2 inches in diameter by an inch and a half deep, with a 1-inch hole in it. The other gauge consists of a solid cylinder of steel, about 6 inches long, one end of which is accurately ground to fit into the hole in the disk.

The CHAIRMAN. I want to know why the enactment of this bill into law would cause anybody to change any of those gauges?

Mr. TOWNE. Because if we had to describe that gauge—ultimately, not right away, but when this compulsory law extends to the people—when we had to abandon the use of the English units we would have to designate that 1-inch gauge by the metric scale and call it a 25.4-millimeter gauge.

The CHAIRMAN. I am talking about this bill.

Mr. TOWNE. That is what the bill would lead up to, and the time to stop such industrial disaster is now, and not later.

The CHAIRMAN. Tell me how it would lead up to it.

Mr. TOWNE. Because you would force us to cease calling that dimension 1 inch and compel us to call it by the metric system.

The CHAIRMAN. Why?

Mr. TOWNE. Because you disqualify the inch.

The CHAIRMAN. Why would we compel you to call it anything but what it is?

Mr. LILLEY. The bill requires the Government to do it.

The CHAIRMAN. No; I think not——

Mr. TOWNE. Absolutely. If the Government should want one of these gauges it must specify it as 25.4 millimeters. To call it an even 25 millimeters would involve an error of one hundredth of an inch, which would be absolutely inadmissible; in many kinds of work the limit of error is one thousandth of an inch or less. To specify it as a "1-inch gauge" (which is what it actually is) would be forbidden under the proposed law.

The CHAIRMAN. That would indicate the measurement down to the tenth of an inch?

Mr. TOWNE. The required accuracy is far finer than that.

The CHAIRMAN. 25.4 millimeters would be no more figures than the tenth, then?

Mr. TOWNE. Now we express it by unity. I am not contending but what, if we were starting a new industrial country, it would be just as convenient to use the mertic system; but I am pointing out that to force us to use a new system of nomenclature for old things would involve endless trouble and confusion.

The CHAIRMAN. You said before when you were before the committee that the immediate effect of the passage of the bill would be to cause manufacturers, and yourself among others, a large amount of annoyance and expense?

Mr. TOWNE. Yes, sir.

The CHAIRMAN. I was not here when your testimony was printed and I want you to explain that to the committee, if you will.

Mr. TOWNE. I will. I have with me some figures bearing on it.

The CHAIRMAN. Referring to page 112 of the testimony, you say, among other things, that you make locks.

Mr. LILLEY. That is the old testimony?

The CHAIRMAN. Yes; of the Fifty-eighth Congress. This occurred during Mr. William Sellers's testimony, and you were asked this question [reading]:

> You make a lock and you make a key to fit it, and it does not make any difference what system is used.

Your answer was:

> That is right; and we make the dimensions of our locks, say a line of padlocks, in fractions of an inch, 1¼ inches, 1½ inches, 2 inches, 3 inches, and so on.

The buyer in the metric market does not care anything about that?

Mr. TOWNE. No, sir.

The CHAIRMAN. Then the question was asked:

> He wants so may locks?

And you answered:

> No; he wants an approximate size. He takes up our catalogue, sees the size he wants, finds the price satisfactory, and he buys it. He does not care anything about the standard of measurement we use in making that lock.

Mr. TOWNE. That is right.

The CHAIRMAN. During the testimony I believe you stated that your business with the Government amounted to about 2½ per cent of your total business?

Mr. TOWNE. Yes, sir.

The CHAIRMAN. Turning over to page 129 of the same book, after going over this subject very thoroughly, and indicating to the committee that it would cost you a good deal of money and inconvenience, you were asked by Mr. Gains [reading]:

To what extent would that reach down to the manufacturers and the people of the country, and compel them also to get the measurements and adopt the metric system in their business.

Your answer was:

It would compel all who undertook Government work to adopt the metric system in their tools and gauges for Government work, and yet to maintain their present equipment of tools and gauges for use in all their other business, or else it would compel them to decline to bid on Government work. Take my own company, for example. About 2½ per cent of our annual business is done with departments of the United States Government. If we were required to substitute metric sizes for our standard sizes, the game would not be worth the candle.

The Government ordering your products, as you say it does, from your catalogue, I wish you would explain to the committee how you would be caused or occasioned a dollar of expense or a moment of annoyance or inconvenience by reason of the pasage of this bill

Mr. TOWNE. If the Government issued all its specifications in metric measures——

The CHAIRMAN. I want you, if you will be kind enough, to confine yourself to my question. I think my question is clear, and I wish you would answer it as I have asked it.

Mr. TOWNE. I understand your question.

The CHAIRMAN. The question expressly negatives anything like that, and it would be absurd to think that the Government would go ahead and specify a lock.

Mr. TOWNE. Under the bill "all Departments of the Government, in the transaction of business requiring the use of weight and measurement, shall employ and use the weights and measures of the metric system."

I will admit that at the outset probably the Government in specifying a 2-inch Yale padlock, which they use considerably, would convert that into the exact metric equivalent of 2 inches, and we could fill the order accordingly; but ultimately, and especially in work made expressly to Government order and not for commercial uses—and we do a great deal of such work—the Government would find such inconvenience in the unnecessary and superfluous decimal fractions which would result in the effort to translate English sizes into absolute metric measures that they would cut off those fractions—they ought to do so—and they would thereby gradually bring the articles used by the Government, and which it has to buy, into convenient metric units, convenient for use and reference.

The CHAIRMAN. Tell me when the Government ever ordered a lock from you and specified anything with reference to the size or the machinery of that lock?

Mr. TOWNE. Frequently.

The CHAIRMAN. I mean, gave any specifications.

Mr. TOWNE. Yes, sir.

The CHAIRMAN. Will you tell us when?

Mr. TOWNE. We furnish all of the post-office lock boxes that are used in Government buildings, and have done so for twenty-five

years. Every time an advertisement is published calling for bids for that material all of the dimensions are specified, very accurately, in hundredths of an inch.

The CHAIRMAN. Do you mean the Government redesigns a lock for you?

Mr. TOWNE. They copy our design and make a drawing for it and publish it so that other manufacturers may bid on that design if they want to, and if it is not patented; and those drawings are made in the office of the Supervising Architect of the Treasury Department.

The CHAIRMAN. If they copy your design, tell the committee how they can put you to a dollar of expense or to a bit of annoyance in ordering a lock that you have designed in a manner suitable to yourself and as you might desire to design it. Tell me how the Government order of that lock could occasion you any cost or expense by the passage of this bill.

Mr. TOWNE. I have answered that question once, Mr. Chairman.

The CHAIRMAN. Tell us how the cost will come in—what tools you would have to manufacture.

Mr. TOWNE. They would nullify the correctness of the gauges by which all of this work is made in order to eliminate unreasonable fractional sizes.

The CHAIRMAN. Why would they do it? They want a lock that you make. I see that you have got away from your catalogue.

Mr. TOWNE. Yes. We make a good many things to order that are not shown by catalogue. If you were transacting a business on a wholesale scale, I fancy you would not resort to the 99-cent price methods as the department stores do.

The CHAIRMAN. Suppose the Government wants a mowing machine, or a sewing machine, or a lock, or a saw. Does it go and design a new machine to do certain work, when it can find a standard article?

Mr. TOWNE. Not necessarily. But it does in particular cases. I have cited one. It is a product made expressly for the Government, the dimensions of which it determines.

The CHAIRMAN. It is a lock you designed expressly for the Government?

Mr. TOWNE. It is a post-office lock box, the sizes of which were fixed by the Government. Let me put it this way: I have not made myself clear. If one of those sizes should happen to work out 99.9 millimeters, the Government would ultimately abandon such an unreasonable and inconvenient figure and call that 100 millimeters.

The CHAIRMAN. But you designed the lock yourself for the Government.

Mr. TOWNE. We did.

Mr. GAINES. On the Government specifications?

Mr. TOWNE. Yes, sir; but the Government is not going to persist in using such an illogical and inconvenient figure. They will change it to 100 millimeters.

The CHAIRMAN. When did anything of this kind happen—that the Government designed locks?

Mr. TOWNE. The Government not only designed, but makes locks.

The CHAIRMAN. When did that happen?

Mr. TOWNE. It has happened every time there has been a letting, sometimes annually and sometimes biennially.

The CHAIRMAN. I should like to find out what occasion there is for the Government to design that lock.

Mr. TOWNE. The Government made the locks used for certain mail purposes in its own factory in this city. It made the lock tools and the product.

Mr. GAINES. Do they not make locks for use on the naval vessels?

Mr. TOWNE. Possibly a very few.

Mr. GAINES. There are locks to all the doors and the rooms on the ship?

Mr. TOWNE. I imagine they purchase most of them.

The CHAIRMAN. Do you think that if the Government was ordering a mowing machine it would specify the size of the crank shaft?

Mr. TOWNE. Very likely. I am not an expert on that.

The CHAIRMAN. Or if it were purchasing a sewing machine would it redesign the sewing machine?

Mr. TOWNE. No, sir; it would look over existing models, and find one or more of them that was satisfactory, and measure up those models, and specify minimum sizes.

The CHAIRMAN. If it wanted a plow, would it redesign a plow, or make a design of its own?

Mr. TOWNE. No, sir; but it would measure up plows in the same way, so that it could describe them by specifications.

The CHAIRMAN. The manufacturer describes them in his catalogue, does he not?

Mr. TOWNE. It is not safe always to trust to a catalogue description.

Mr. SCROGGY. In either case, of sewing machines or plows, would it be necessary to have new machinery?

Mr. TOWNE. That would depend upon the extent of the changes.

Mr. SCROGGY. Suppose they ordered the same thing?

Mr. TOWNE. Of course it would not involve any change, then.

May I give you some expert testimony upon the subject of what this change would mean? This question has been discussed in England as well as here. Mr. Tannett-Walker, of Leeds, one of the leading English engineers engaged in the metal trades, gave it as his careful opinion that the cost to his concern of changing from the English to the metric system, in the alteration of their tools and gauges, would average from $50 to $75 per man.

The CHAIRMAN. Of course that is an entirely different question.

Mr. TOWNE. Dr. Coleman Sellers, one of the highest authorities in this country, has said that it would cost at least $200 per man. Mr. McFarland, vice-president of the Westinghouse Electric and Manufacturing Company, put it at $650,000 for their Pittsburg works only.

The CHAIRMAN. Does not that involve the immediate going from one system to the other, and the changing of all of their standards, where they do not come out in even metric sizes?

Mr. TOWNE. It does, and that is just what we are afraid of, and what we want to forestall.

Mr. GAINES. On page 116 of the hearings of 1902, in the testimony of Admiral Melville, the very question you are discussing was taken up.

The CHAIRMAN. I understand; but we can not go over all the testimony.

Mr. TOWNE. May I ask your attention to this point: Here is Mr. McFarland, of the Westinghouse company, who says that it would cost $650,000 in his own plant. The estimate of the English manufacturers in one of the printed reports is $500,000,000 for Great Britain. I gave you two years ago my guess as to what it would mean—not less than $1,000,000,000 in this country. To my own concern it would cost between $300,000 and $400,000.

Mr. Littauer, the author of this bill, says that he thinks it would cost "about $1,500,000." What is such testimony as that worth? Mr. Littauer knows nothing about what he is talking of. I imagine that he would not know what such a thing as this is if I showed it to him [exhibiting a gauge], and yet he says expressly that he thinks "a million and a half dollars might possibly be involved," when competent authorities and experts tell you that it will be anywhere from five hundred to a thousand millions.

Mr. GAINES. Tell me the size of the hole through this cylinder that you have described.

Mr. TOWNE. One inch.

Mr. GAINES. That is an inch?

Mr. TOWNE. Yes.

Mr. GAINES. Suppose it was a hole made through there by the metric system, to represent an inch, what size would the hole be there—larger or smaller?

Mr. TOWNE. It would be exactly the same. [Laughter.]

Mr. GAINES. All right.

Mr. TOWNE. Only we would have to use metric figures, "25.4 millimeters," to indicate the size instead of "1 inch." It would be the same hole, if that is what you want to get at.

Mr. GAINES. It would be the same size and look just the same and be in the same place? [Laughter.]

Mr. TOWNE. It would be the same old hole, in the same old place. [Laughter.] But you would be compelled by law to call it by another name.

See what fractions this runs into. Here is an ordinary gauge that is constantly used in my business. The standard size for the plug of the Yale lock is 0.51 of an inch. Here is a ring gauge which is exactly that size, and here is the plug gauge that enters it [exhibiting gauges]. There is another gauge which is one-thousandth of an inch bigger which must not go in and will not [showing]. In inspecting actual work the lock plug must enter a guage like this and must not enter a gauge which is as big as this one [indicating]. In other words, one-thousandth of an inch variation causes a rejection of the work. We can not afford to change all these tools. We have hundreds of thousands of dollars invested in them, and if the metric system prevails and we are forced to use it we will keep these actual sizes and will have to renumber them on the metric scale and give our workmen a strange and incomprehensible language to work with.

Mr. GAINES What are the chances of mistake in using the metric system?

Mr. TOWNE. If you are equally familiar with the two systems the chances of mistake are no greater; sometimes less. But for a person

unfamiliar with the metric system the chance of error is vastly increased, of course.

Mr. GAINES. Do you not use more figures with the metric system than with the English system?

Mr. TOWNE. That is a moot question. In some kinds of work, no; in some kinds of work, yes.

Mr. BOWERSOCK. If this bill should pass, when do you think these changes which you have described as being so expensive would have to be made, and over how long a time would you anticipate or think that this $100,000,000, or whatever it is, might be spread?

Mr. TOWNE. It would take a great deal of time. It would almost bankrupt the metal-working trades if we had to do it completely even in fifty years. To reply to your question, the answer varies with different cases. In the industries which are building lathes and planers and shaping machines, and so on, for the Government for use in building guns or to build machinery in the Brooklyn Navy-Yard for the war ships those machines are designed to-day for working in English units, and the work they produce is stated in English inches. If the Government should start over and begin its designing of ordnance, engines, and ships on the metric system many of the existing machines could be used, but some of them could not. Even those which could be used would be inconvenient and expensive in use in many ways. So that from the outset there would be pressure put upon the manufacturers to begin to switch over to the metric system, and yet they would have to maintain their old system of machines, units, standards, and gauges for their commercial work. You would vastly multiply the investment in facilities of that kind, and would have confusion where we have now unity and peace.

The CHAIRMAN. I want to call attention to the fact that one hour and forty-five minutes has been consumed by this witness.

Mr. TOWNE. I have taken more than I am entitled to. I can finish in about thirty minutes what else I have to say. If the others claim the time, I must surrender it.

The CHAIRMAN. We were going to devote only four hours a day to this bill.

Mr. GAINES. What other branch do you want to discuss now?

The CHAIRMAN. And we have not that much time to-day.

Mr. TOWNE. I have discussed already the subject of decimal notation, absolute units, measures of length and uniformity, and I have nearly completed what I wish to say on the effect of the change on domestic interests. I want to say a few words as to its effect on foreign interests, and especially on its effect on Government interests. Then I am through, except a suggestion.

Mr. GAINES. Have you what you want to say in writing?

Mr. TOWNE. No, sir; these are only brief notes. I can finish in about half an hour, if I am permitted to continue.

The CHAIRMAN. I understand you to say that this is all arranged between those who appear to oppose this measure, that you shall represent them.

Mr. TOWNE. I have no authority for any such statement.

The CHAIRMAN. You understand the rule that we have adopted?

Mr. TOWNE. I do, and that I have had more than my share of time.

(After an informal discussion as to the time to be consumed in the succeeding statements it was agreed that a recess should be taken for thirty minutes.)

Mr. BOWERSOCK. I wish to make one suggestion. I think you misinterpreted Mr. Littauer's statement in reference to the saving made in his office force. I think you referred it to his adoption of the metric system, whereas he stated that it was the use of the decimal system and computations in his office that had made the saving.

Mr. GAINES. My recollection is that he said the metric system.

Mr. BOWERSOCK. I think it was the decimal system.

(Thereupon the committee took a recess for thirty minutes.)

AFTER RECESS.

The CHAIRMAN. I wish to say that so far the negative has had one hour and fifty seconds. They have ten more to-day. Who will occupy that time?

Mr. TOWNE. I will ask that Mr. Mattice be given the floor.

The CHAIRMAN. Very well.

STATEMENT OF MR. HENRY R. TOWNE—Continued.

Mr. Chairman and gentlemen of the committee, when I left off yesterday I had partly discussed the question of the influence of this proposed bill on domestic affairs. The avowed purpose of the bill is to serve as an "entering wedge" for the compulsory use of the metric system by the people. This is admitted by its author. Such a law would be revolutionary, of our industries, at least, and of the weights and measures used by our common people, more revolutionary a great deal than would be the change of our currency into some other system than the decimal system, and I submit that no such revolutionary legislation ought to be taken except in response to an overwhelming popular demand. Does such a demand exist? Is it not a fact, on the contrary, that not a single Member of the present Congress has any mandate from his constituency to promote and demand this fundamental change in our institutions? The urging for the bill comes——

The CHAIRMAN. What do you mean by that?

Mr. TOWNE. May I ask that I be allowed to finish my argument first, and then I will be glad to apply any time that is left to answering questions?

(The stenographer was asked to read the last statement of the witness.)

The stenographer read as follows:

Is it not a fact, on the contrary, that not a single member of the present Congress has any mandate from his constituency to promote and demand this fundamental change in our institutions?

Mr. SCROGGY. I would have to challenge that statement.

Mr. KNOWLAND. I would challenge that also.

The CHAIRMAN. The witness desires to proceed.

Mr. TOWNE (continuing). Mr. Stenographer, will you insert one qualifying word in that statement, namely, make it to read, "from a majority of his constituents."

It seems to me that neither group of the people who stand on the two sides of this question—I belong to one group—is justified in seeking to impose on the other group its preference in this matter of our units of measure. Each of us is at liberty, under the law of 1866, to select the one or the other system and to use it, and the effort to compel either side by means of legislation promoted by the other to abandon its preference and to use the other system is uncalled for, I think, to say the least. We have abundant evidence to show that in the countries where the change has been made the old units have persisted for a long time. We have testimony from authorities on the other side, if you please, not the antimetric but the prometric side, that the change, if made, would not be completed in ten years or in a hundred years—that it would be a question of generations.

We have to-day in this country that which chiefly moved France and Germany to adopt the metric system, namely, national uniformity. The adoption of the metric system would destroy that uniformity and would for a hundred years substitute for it confusion and disorder. I submitted yesterday figures from competent authorities, and from quite a number of them, showing that the change would ultimately compel an expenditure on the part of American manufacturers of not less than $500,000,000, and, in the opinion of some, of exceeding $1,000,000,000, against which we only have the opinion of Mr. Littauer on the other side, who "thinks" it might cost $1,500,000. I submit, gentlemen, that evidence of that kind, mere opinion and hearsay, without any foundation of experience, ought to have no weight in your minds as against the contrary evidence of competent experts.

Now, as to the effect of this proposed change of our national standards on our foreign interests. It is urged, as a chief argument in favor of the change, that it will promote our export trade. If so, that is pertinent and important. I have a personal interest in that question, as the business of my company with foreign countries is considerable. But is it a fact, gentlemen; is it true? What does experience show in this respect? Has the nonuse of the metric system retarded the growth of our exports of manufactures? In 1895 they were $40,000,000, or 12¾ per cent of our total exports. In 1905 they were $543,000,000 (the manufactures exported from this country), or 36.44 per cent of our total exports. That shows an increase in ten years of thirteenfold in our exports of manufactures and of threefold in their percentage of our total exports!

Has the nonuse of English measures by France and Germany decreased our consumption of German and French goods? Would we import any more of those goods to-day if those countries changed from the metric to the English system? Has this question in fact any perceptible influence whatever upon the volume of our foreign trade? I know of no evidence to justify that assertion, nor are the great exporting and importing commercial houses in evidence as urging, or even as desiring, the proposed change. Surely the foreign trade of the United States is a factor which ought to be considered most seriously in connection with this bill. Let us see what are the essential facts relating to it. The total of our exports the year ending June 30, 1905, was $1,518,000,000, of which to Great Britain and the

British Empire there went $741,000,000, or 49 per cent. Those to the British Empire, China, and Russia were $820,000,000, or 54 per cent of the total. Those to all the other countries of the world were only $698,000,000, or 46 per cent of the total.

Of our imports $330,000,000, or 29 per cent, came from Great Britain and the British Empire, and $370,000,000, or 33 per cent, from the British Empire, China, and Russia; the remaining $747,000,000, or 67 per cent, came from other countries. In other words, so far as our export business is concerned, much more than half of it is done to-day with countries which reject the metric system and use the English, and in making any such change as is proposed we should be hurting, not helping, our export trade. Our best market for our cotton goods is China, in which the English units prevail, and last year China took $33,000,000 of our cotton fabrics. Therefore, gentlemen, the net effect of the change on our export trade, in my judgment, would be an injury rather than a gain.

Now, finally, as to the effect of this change on the Government. This involves three interests; our foreign commerce, our domestic trade, and the Government itself. No argument has been offered to show that the Government would be directly benefited by this bill. Even its author makes no such claim. He says, on the contrary, that the bill is an "educational measure." The purpose of it is to lead, gently and kindly, the people of this country from their ignorance into light, to show them they don't know what is best for them in this respect, and that, if we will only force them to make the acquaintance of the metric system, it will compel their approval and its ultimate acceptance. I ask is not this paternalism carried too far? Is it the proper function of Congress to enact legislation of this kind, unless in response to some overwhelming demand of the people? In the present case there is no such demand; on the contrary, the people whose pockets would directly be affected by this bill, the great manufacturing interests of the country, so far as they have appeared before your committee, overwhelmingly oppose the proposed change.

In other countries where a similar change has been made it has taken years of preliminary study to determine, first, if it should be made at all. In France it took eleven years; in Germany it took eleven years; in other countries it took from one to five years. In every case this preliminary study has been done by the appointment of a technical commission, carefully to take evidence, to investigate, and to prepare a report upon which the legislators of the country could base action with confidence that they were acting wisely. If we are to have a change, ought it not to be preceded by a technical investigation of that kind?

Now, gentlemen, let us consider some of the effects of this bill, if it means what it says. I would like to point out one uncertainty in it. It says that from and after the 1st of July, 1908, "all the Departments of the Government of the United States, in the transaction of business requiring the use of weight and measurement, shall employ and use the weights and measures of the metric system."

It does not say that they shall use it exclusively, but I presume that that is what it means. It says that they shall "employ it." Assuming that this means that they shall employ only the metric system, let us consider the results. First, in regard to Government busi-

ness, it would absolutely disqualify 99 per cent of the present force of Government clerks for doing their work until they had familiarized themselves with the metric system. It would for years add greatly to the time and cost of all Government accounting and of all clerical work done for the Government, because of the lack of familiarity and expertness on the part of the clerks. It would greatly increase the tendency to error, because they would be working with unfamiliar scales. It would make the Government reports, which are supposed to be published for the people, unintelligible to the people. It would preclude the ready comparison of future statistical reports by the Government with past statistical reports, or with the statistical reports of our most important competitor, Great Britain, and her colonies. It would make void the engineering and technical formulæ which our Government engineers, Army and Navy, naval constructors, naval architects, and so forth, have used all their lives. These are not things which can be changed by legislation at will. They are things which, like the multiplication table, are based on lifelong habit and which persist. Here are a number of technical books [showing] filled with data and formulæ in the British units, the foundation of all engineering work, all of which would have to be translated into a language which is new and unintelligible to the men who use these books.

The proposed law would compel the Government and the seller, in every transaction with the Government, to express that transaction in two systems; in the metric system for the Government, and in the English system for the seller. It would compel the Government, in obtaining all commercial products—that is, those made commercially for the general market—to describe those products in alien terms and in interminable fractions. For instance, a bar of 1-inch iron as 25.4 millimeters; a $\frac{7}{8}$-inch bolt as 22.225 millimeters; a 12-inch plank as 304.8 millimeters, or as 0.3048 meters; a ton of coal as 1.016 tonne; a gallon of oil as 3.785 liters, and so on. It would cause the smaller manufacturer and dealer to reject Government business. It would increase the trouble and cost of doing all business, by everyone, with the Government. It would create confusion and disorder where we now have uniformity and order. And, finally, it would compel an entire rewriting and translation into a new language of the Dingley tariff law.

I will now take just a few minutes more in which to sum up my conclusions on the several heads under which I have discussed the subjects covered by the proposed bill.

As to decimal notation, we have first of all a frank confession of its conveniences and advantages, but a denial that the decimal system is the best for the ordinary uses of the people. Whether so or not, the metric system has nothing to do, necessarily, with the question of having our measures decimalized. We can have decimalization without regard to the metric system. As to absolute units, an analysis of the metric and British units has shown that there is no substantial balance or preference for one or the other.

As to measures of length, however, it has been shown that the meter, or its subdivision, the millimeter, are neither of them as good as the foot or the inch, even metric users admitting the fact; and therefore we would be changing from good to bad in that respect. But many of our measures of length we can not alter. They are

"linked irrevocably to the past," and in such a way that they never can be changed.

It has been shown that the greatest object sought by every nation in changing its system of weights and measures has been to obtain uniformity. We have now absolute national uniformity and international uniformity with Great Britain in everything except measures of volume. No such condition exists in any other country. No so-called metric country has to-day complete national uniformity. We have absolute national uniformity and (excepting in measures of volume) international uniformity with the British Empire, they and we producing jointly more than one-half of the total manufactures of the world. France and Germany combined produce only about 23 per cent of the total manufactures of Europe and America, whereas the British Empire and the United States jointly produce one-half. Thus tested, the English system stands on an equality with the metric, and there is no more argument for our accepting their units of length than for their accepting ours. The decimal scale is a separate question. If the metric system were adopted, I repeat that one hundred years would not see the disappearance of our present units from popular use. As to the influence on foreign trade, I need not review that again. All that the manufacturers of the country ask of you in this respect is to let well enough alone and not to do anything revolutionary, especially as to our measures of length.

But now it may properly be assumed in any discussion of this kind that those who oppose action evidently intended honestly and sincerely to be in the direction of improvement shall not stop with opposing that action, but shall go further and offer some substitute, shall offer something better than that which they are opposing; and in that spirit I venture to make this suggestion, that if you shall decide finally not to report favorably on the passage of the Littauer bill, your committee can do a most useful and constructive work by then drafting and offering for consideration a bill which will aim to improve our present system of weights and measures. The opponents of the metric system, including myself, admit the existence of many crudities and imperfections in our present system of weights and measures, but this objection applies not to the units, but rather to the scales by which those units are expressed, to their multiples and subdivisions. The subdivisions of the pound, the bushel, and the yard, for example, are crude, and there are too many of them. There is no difficulty whatever in making a reform in this respect which will command the hearty cooperation and indorsement of manufacturers, and I think of our people generally.

Mr. LILLEY. Do you not think that can best be brought about by a convention of the people who are using them?

Mr. TOWNE. I am coming to that. We might very well adopt the declaration of the British Weights and Measures Association, except as to their measures of volume, viz, "The defense, standardizing, and simplifying of British (and American) weights and measures." In this connection note how closely the British and American base units lie together. Take first the pound. The pound avoirdupois is 7,000 grains; the pound troy and the apothecaries' pound are each 5,760 grains. They are alike in Great Britain and America. It should be the simplest matter in the world for a competent commis-

sion to construct a new system of weights, using the grain as the unit, and making the pound the chief multiple of that unit, so as not to confuse the people as to the value of the units, and thus to get rid of many of the "excrescences," as they have been called, and very properly, in our present subdivisions of the pound, such as ounces (of several kinds), scruples, drams, etc.

So, also, as to the English and American linear measures—the inch, foot, yard, and mile; the square inch, foot, yard, and acre, and the cubic inch, foot, yard, and ton. The British and American gallon and the bushel differ.

The divisions and multiples of base units constitute a proper subject of reform, and also the harmonizing of American and British units, and, in the case of the pound, a slight change would bring the English system of weights into harmony with the metric system. By all means attention should be given to that question.

The CHAIRMAN. Would not that carry some expense to the manufacturers?

Mr. TOWNE. Changes of weight and volume?

The CHAIRMAN. Yes.

Mr. TOWNE. If the proposals in this direction were wise and conservative they would be welcomed by the people. Probably also the English Government would listen to a proposal in this direction, if properly presented. Therefore my suggestion, gentlemen, would be in this direction, that a bill should be drafted covering in substance the following proposition: First, a technical commission, such as France created when the metric system came into existence, and such as Germany created later, such as we have had for other purposes, and such as Great Britain has had again and again; a technical commission to be appointed by the President, with due representation of scientific, technical, industrial, commercial, and popular interests, and with due provision for assistants and expenses. Second, the President to invite the British Government to participate, either by creating a like commission or by appointing delegates to ours, thus making it international (as France did in 1790, when five other nations participated) between the United States and the British Empire. Third, to hold public hearings to take evidence and to invite suggestions. Fourth, to require the commission to report annually the results of its work and the plans under its consideration for the information of Congress and the people. And fifth, the commission, when ready, to report a bill for consideration and action by Congress, embodying its conclusions and final recommendations; if possible, one which Great Britain also would approve and would seek to adopt, thereby creating an international uniformity as well as the national uniformity which now exists and which would then prevail and continue.

Mr. RAYNAL. Under the terms of your proposition, could your commission adopt the metric system, bearing in mind that it is not to be based on the inch? Now, I ask you, would it be possible for such a commission to accept such a method?

Mr. TOWNE. If I had legislative power I would refer this whole question to a technical commission, to study it with a free hand, to bring in a report recommending the metric system entirely, if they see fit.

Mr. LOVERING. Should not that be composed of scientific men entirely?

Mr. TOWNE. No, sir; not exclusively. In my judgment it should consist of representatives of all important interests and professions. In this way, and in this way only, I believe we would arrive at a final and satisfactory solution of a question which, since 1816, has almost continuously been before Congress and the people. Until such a solution is found and adopted this question will continue to be agitated, in Congress and elsewhere. Let us arrange to solve it as other nations have solved it, by means of a competent commission of technical experts, whose work shall form a foundation for legislation by Congress, and let us do this now.

STATEMENT OF MR. W. B. COWLES, OF THE NATIONAL METAL TRADES ASSOCIATION, CLEVELAND, OHIO.

Mr. COWLES. Mr. Chairman, and gentlemen of the committee, I am vice-president and treasurer of the "Long-Arm" System Company, Cleveland, Ohio. I am a member of a whole lot of technical societies and engineering societies. I am also here representing officially the National Metal Trades Association, being chairman of the special committee appointed by that association to oppose this bill. I also represent the Manufacturers' Association of Cleveland.

I have no fiscal arguments, and I am not going to bother you with a lot of figures. The theories don't bother me one little bit; theorists pester me awfully. I am up against practical conditions. I am a Government contractor and subcontractor on naval work, ship fittings, parts of war ships.

This bill says "shall" and it does not say "may." This bill makes it mandatory on the Navy Department, and I am going to speak right on that point. I don't know a thing about other Departments. It makes it mandatory on the Navy Department to use metric measures—the metric system—on all Government work after a certain date, which is near enough to make a man shiver. If the bill means what it says in plain English terms, then the Navy Department, through its principal mechanical bureaus—the Bureau of Construction and Repair, the Bureau of Steam Engineering, and the bureaus of Ordnance and Equipment—are forced to use the metric measurements in all Government work under their supervision after the date specified. And if it is a question of interpretation, problematical interpretation of how that bill will be carried out by those Government officers, I want to say that I can interpret that just as well as any man here in this room, because I am bone of their technical bone and blood of their blood. We have a common alma mater. I am a graduate of their Naval Academy. I know how they form their opinions and what is in the backs of their heads, and, furthermore, I know what their idea of duty is. So I can say, gentlemen, that they are going to obey the law to the letter. No civilian knows what the military or naval idea of duty is unless he has had a chance to see it in a war or has been associated with them. Those officers are going to interpret that law literally and carry it out literally and "let the deluge come" if it will; there is no question about that. I am talking about what is up against me good and hard.

When they carry out the terms of that bill, if it becomes a law, it puts my company and my stockholders up against this condition. I don't care for the arguments to the contrary. I don't want any "physicist" or any professor or any astronomer or astrologer from the skies to tell me what will go on in my works. I will tell them. I don't want any Government official or any subofficial from our new Department of Commerce and Labor to tell me what it will cost me. I will tell them. They are not in a position to tell me. They don't hold any brief to argue that case before me; they don't know. And I have noticed, in sitting here and listening to these arguments pro and con, that the two sides can not get together. The theoretical man, the "physicist," and the practical manufacturer in metals can not get together any more than the Mohammedan and the Hindoo. There is no common ground. They don't touch, unless the "physicist" and the theorist has gone on in his development and become the practical man of affairs. I don't propose for a moment to admit that the "physicist," the scientist, and the astronomer can tell me anything about my business, because they don't know. And I regard it as an insult for them to come and dictate to me; just as much of an insult as it would be for me to go and dictate to them about their astronomy or their particular science. Why should those people attempt to dictate to me about my business?

Mr. GAINES. How will it hurt your business, Mr. Cowles?

The CHAIRMAN. What part of your business is Government business?

Mr. COWLES. The majority of it until lately. Now it is Government business and automobile parts.

Mr. GAINES. Tell us how is will hurt you.

Mr. COWLES. Coming right down to the inch—I will only use one measure. The inch is 25.399 millimeters——

Mr. WEBSTER. That has been said again and again, and it is not so.

Mr. COWLES. I manufacture my goods to standards. They are now manufactured to complete working drawings submitted and approved by the Navy Department, and in many cases the fits and measurements go down to a thousandth of an inch for duplication. The Navy Department will do one of two things. It will demand that those drawings and specifications be carried out on the basis of the inch transformed to the metric millimeters in a cumbersome, awkward decimal of some kind—and that is a thing I can not put into my work, and I don't propose to argue about that, but simply tell you the fact that I can not work to those cumbersome fractional measurements in the metric system——

The CHAIRMAN. It is the same measurement, is it not?

Mr. COWLES. It is not the same measurement. It is the same distance expressed in another measurement.

The CHAIRMAN. Yes; the same distance.

Mr. COWLES. That is the point. It is the same distance expressed in another measurement, and that puts me to an impracticable expense and into an impracticable position, and I can not carry my work out that way.

The CHAIRMAN. That would not cause you to change your tools?

Mr. COWLES. Wait a minute. It would cause me to change my tools, because I can not work to those mixed-up measurements. It changes——

The CHAIRMAN. You could not make other tools?

Mr. COWLES. I could not make other tools?

The CHAIRMAN. You could make other tools, but if you made other tools they would be duplicates.

Mr. COWLES. Gentlemen, I would either go out of the business or be put to the expense of some sixty-odd thousand dollars in my particular case in getting out new plans, patterns, jigs, and tools to make the present commercial material go into that Government work specified metrically. Now, the other horn of the dilemma is this——

The CHAIRMAN. May I ask a question there?

Mr. COWLES. Yes.

The CHAIRMAN. If they were the same measurements expressed in a different way, you would have to reproduce the same tools to do the same work?

Mr. COWLES. It would not be practical to do it.

The CHAIRMAN. You would be obliged to?

Mr. COWLES. Practically I can not do it.

The CHAIRMAN. But practically you could not duplicate that work without the same tools.

Mr. COWLES. That is true, and I could not use those tools.

The CHAIRMAN. And if they are the same measurements differently expressed you would have to reconstruct the same tools to make the same work.

Mr. COWLES. But I could not use those complicated measurements. The practical result would be that the Navy Department, either at first or after they had tried it once, would not use those complicated measurements and odd fractions in the metric system; they would go to even expressions in the metric system, and that also would make me change.

The CHAIRMAN. You mean they might in the course of time?

Mr. COWLES. I think I know just what they would do, and I have not got the big head about it, either; from my experience in judging those people for many years I can say that they are not going to stop at the change from English to awkward fractions of the metric system; they are going to insist upon the carrying out of the even metric measures. And that is where it hits me, and it means that I have got to have two measures in my shop; it means I have to order all of my material on two different bases, and I can not get the metric material.

Mr. GAINES. You said you would lose $60,000 in the matter of tools if this bill were passed. How much have you invested in your concern? I wanted to get at what the whole of the United States would have to pay.

Mr. COWLES. In the plant——

Mr. GAINES. The whole thing.

Mr. COWLES. About $300,000.

Mr. GAINES. How much in tools?

Mr. COWLES. You mean machine tools or jigs? I haven't been referring to machine tools. If I had to change my machine tools to get the metric screws it would run up to somewhere above 25 per cent of the whole.

Mr. GAINES. What you know you would have to change would amount to $60,000?

Mr. COWLES. Yes; I could not produce a metric thread on any machine I have.

STATE UNIVERSITY OF IOWA,
DEPARTMENT OF PHYSICS,
Iowa City, Iowa, March 19, 1906.

Mr. JAMES H. SOUTHARD,
Washington, D. C.

DEAR SIR: I have been informed that at the last meeting of your committee the statement had been made by the president of the American Society of Mechanical Engineers that the English inch was used as much in Germany in manufacturing as was the centimeter and the millimeter.

About two years ago I attended as a visitor one of your meetings, when Messrs. Halsey and Dale testified to the failure of the metric system in European countries, and was greatly surprised by the remarkable statements of those two gentlemen, which, to me, who had been brought up in Germany, seemed nothing but distortions of the actual facts. However, not being a business man nor a manufacturer myself, I wished to obtain unprejudiced information, and wrote to several friends of mine in the old country, sending at the same time several copies of the "Metric Fallacy." One of these men is a large manufacturer of machinery, another a lumber dealer, one a naval architect, and one a wine merchant, i. e., all engaged in those branches of business which, according to Halsey, showed more than any other a survival of the old system.

From all of them I received the most emphatic denials of Halsey's statements, their letters being of greatest interest to a student of the present movement to introduce the metric system in the United States.

In connection with the above-mentioned statement of the president of the Society of Mechanical Engineers I wish to say that Dr. Oskar Knoevenagel, a well-known manufacturer of machinery, whose yearly output amounts to 600,000 to 800,000 marks, makes, among others, the following important statements:

> In our iron industry we measure exclusively according to the metric system. Whenever we speak of English inches, especially (A) in connection with the Whitworth screw thread, (B) tubes, (C) nails and screws, we have to think of them only as a notation of magnitude (i. e., names), * * * but, be it well understood, we *measure* only according to the metric system, even where we have to do with the English name. * * * Our scales are exclusively metric, with millimeter subdivisions. All names, except those mentioned, are also in the metric system.

It is clear that the opponents of the bill also in this case, as in so many others, make the mistake of assuming that a survival of a name means survival of the measure.

It may interest you that a few weeks ago the senate of the University of Iowa passed a resolution in favor of the pending bill, and ordered a copy sent to our Representative in Congress.

Hoping that your efforts for the simplification of our present unsatisfactory system of weights and measures will be crowned with success, I remain,

Yours, very respectfully,

KARL E. GUTHE,
Professor of Physics, the State University of Iowa.

WASHINGTON, D. C., *April 2, 1906.*

Hon. JAMES H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures,
House of Representatives.

DEAR SIR: I have read with great interest the discussion regarding the introduction of the metric system in the United States. I am a mechanical and steam engineer, and at present in this country on some turbine business. I am a native of France, but most of my life has been spent in Spanish and Spanish-American countries. I have had varied experience in metric countries, practical experience in machine shops and engineering establishments, an experience which causes me to read with amusement, and sometimes amazement, the misstatements reiterated by some of your engineers.

I have been foreman of a large engineering construction company, the Companhia Docas de Santos, São Paulo, Brazil. We had 4 power houses, some 18 locomotives, 15 boats, 300 pile drivers, and about 150 hydraulic cranes in operation day and night at the loading and unloading docks. We had a large repair shop and foundry, in which we employed from 250 to 300 skilled operatives—machinists, founders, brass workers, blacksmiths, and others. As foreman of that shop I have always used the metric system and I never thought I could come to use the English system of feet, inches, and yards, although I have since done so, but I find the English system more awkward in every way.

I have also been two years in Buenos Ayres, in Argentina—certainly the most progressive country in South America. During this time I was engaged with the Compania Primitiva de Gaz. There I always used the metric system in our work and would never think of using anything else, because there was absolutely nothing that would answer the purpose of practical work as well as the metric system. Its use is universal in Argentina for all purposes. For seven years past I have been associated as engineer with the jute, cotton, and woolen mills of the Companhia União Fabril de Rheingantz & Cie., in Rio Grande Do Sul. During my connection with this company I have had constant occasion to order machinery and we have always ordered by the metric system. We were hindered many a time in ordering in the United States, because we could not use the inch system, having decided preference for the metric units. We therefore ordered our machinery from English, German, and French and other European firms which were able to furnish machinery built on the metric system. I know from experience that the machinery made in England for export to South American countries is built on the metric system, because in South America we know both systems, but we want to use no other system for our work than the metric system. It is the only legal system in South America.

The first point I must deny emphatically is the alleged use of old units in South America to any extent. The metric system has unified the weights and measures of all the South American republics, together with practically all the European countries. I believe we have a uniformity between the various countries of South America such as you have not from State to State in your own country.

The old names of measures where they are still used represent metric units, not the old units at all. This is where your consuls and your correspondents are mistaken. They give the metric equivalents

of the old values taken from some dictionary or historical work. The fact is that the old names are simply nicknames for the metric units themselves. A "libra," for example, is not the old Spanish pound, but the half kilo or 500 grams. The old "libra" exists only in name. I wish to limit my statement to those countries with which I am familiar from personal observation. In Spain the old Spanish pound is not used; the word is now a name for the half kilo, among the country people especially. The Spanish "vara" is exactly 1 meter. The old arroba is now exactly 11 kilograms, not the old value. The old "tonelado" or "ton" is 1,000 kilos or 1 metric ton, no more or less. Likewise the Spanish "cuartillo" is exactly 1 liter or 1 cubic decimeter. The old units have been dropped, but the old names were given to the nearest metric unit.

Coming to Brazil we sometimes hear the old Portuguese names still used colloquially, but only the name has survived, not the unit as a quantity. The units themselves are metric. The vara in Brazil, when an old man speaks of it, is 1 meter in length; the brasa is 1½ meters. You can figure in brasa, but it is understood that your brasa are exactly 150 centimeters. So the garrafa is half a liter, the arrova 15 kilos, the milha 6 kilometers. I do not say these names even are common; they are used by old people and in the country districts or by the illiterate and are fast disappearing even as names for the metric units. The quantities or old values have already disappeared and are preserved only in historical notes in arithmetics or almanacs for some consul to puzzle himself over. The greatest legal complications I have ever known are the land litigations in southern Brazil, caused by the use of the ancient surveys based upon the "milha," a unit used in Portugal two hundred years ago. When the Portuguese surveyors first came to Brazil, each carried his own "milha," and as each province had a different milha, the result may be imagined. The metric system proved the remedy for this confusion. In the courts the metric system was the only one in which the different surveys could be brought to a common basis, and at the present time the old measures exist only in name, although the litigation has already extended over more than half a century.

In Argentina the arroba is exactly 10 kilos. We use the libra for weights, which is 500 grams, or half kilo, but it is very seldom used, even as a name, and is going out of use. We never hear any more of the pié (the old foot) or the botilla. Whenever they are mentioned they refer to an even number of metric units. The vara is 1 meter, as the old vara in Brazil, Spain, or Argentina has no legal standing, so far as I know. All must be expressed in metrical units, because they are the only units known by everybody. You will find even the most illiterate people knowing perfectly well the metric system, and they have no use for any other.

In Uruguay and Chile the same is true, and, I believe, in all other South American countries. In brief, the metric system is thoroughly established. Old names are simply nicknames applied by the lower classes to the metric measures, just as your people call the 1-cent piece a "penny," which it strictly is not. But even the lower classes do not use the terms in dealing with strangers or people of better education. All classes prefer the metric system and the metric names.

It is an outrageous misrepresentation of the facts to say that the old units are in general use even by the common people. It is incredible that anyone should state that the metric system has not introduced uniformity in weights and measures throughout the continent of South America. I assert positively that the metric system is a great success in South America.

One point, I think, is not generally known, and which any native of South America can corroborate. In Brazil you may ask a child before he has ever been to school, and he will show you that he knows perfectly what is a kilo, a liter, and a meter, and even their more common divisions. Children absorb this knowledge without special teaching and with the same readiness as your children in this country learn what is a cent, a dime, and a dollar. They are both decimal, hence as easy as counting numbers. If you want to be convinced of the popular knowledge of the metric system among even the ignorant classes in continental Europe and other countries, I would suggest that you ask the common Italian laborer immigrant in this country, and you will find that even those who can not write their own names still have a clear knowledge of the metric units, including all their multiples and divisions, so simple and easy is the system.

If the United States adopts the metric system, which I hope it will, there would be of course a transition period. I understand the system is already in use to a considerable extent in your country. The inconvenience which would exist during the transition period has been misstated. During the transition I am positive the inconvenience will be slight and the confusion not worth talking about. I know from actual experience and do not hesitate to assert that the two systems can be used side by side without confusion, as I have used them side by side myself and am still using them. I have just designed, among other things, some special steam valves for turbine work. My drawings are being made in metric units, to be used, however, in an American shop for construction by the inch. The two systems will not clash. The transition period may be as long as necessary to minimize expense.

Take the matter of repairs. The repairs on any machines can be as easily made by metric-made tools as by inch-made tools. An engine comes to the shop for repair. We are going to repair the piston rods, pins, crank pins, crosshead pins, and make new bushing for all these, make new brasses to fit either the new pins or the old ones. Now, we turn down these rods and pins until they are parallel, taking off as little metal as we can. There is no measure involved no matter what system they were originally built by. All that is required is to get them parallel. Then, we make the new bushing to fit the rods and the new brasses to fit the pins as cut down, but without bothering about the actual new size in inches or millimeters. So much for repair. Now, take new construction. A carpenter cuts his lumber indifferently to an even number of inches or an even number of centimeters. Just so in shops. A pattern going to the foundry is always larger than required for the finished machine to allow for the inevitable shrinkage of the casting, possible distortion, and, in addition, machining or cutting down the casting to size, leaving a finished surface. The casting must be cut down, and it is just as easy to cut down three millimeters as one-eighth inch. It is only just a question of terms.

It is just as easy to cut 1 millimeter as one thirty-second inch. The allowance is always ample to make the slight difference of no consequence in the large majority of cases. For finishing where the size is to be fitted, a slow-speed motion will require less clearance than a high-speed machine. It is just as easy, however, to cut 0.1 millimeter as 0.004 inch (its equivalent), for accurate fits can be more simply expressed in metric units. Where large numbers of parts are being manufactured limit gauges are used, and then no measurement at all is necessary.

In "individual" construction no good mechanic would undertake to fit parts without actually trying them; that is the practical way. He need not measure the difference, but trims until it fits. With calipers he does this easily. A pulley is to be fitted on a shaft, and the trim may be large or small, according to the size of the shaft. If I had templets and drawings made by the inch, I would continue to use them until worn out. Then it would be as cheap and as easy to replace them by millimeters.

No one experienced in machine work would make the mistake of saying that a gradual change would be as expensive as a sudden one. The truth is that a gradual transition would almost avoid the entire expense of change. Machines and tools wear out; new machines and new tools are designed. The sensible businesslike way, as was done in other countries, is to replace old tools as they wear out with metric tools, which cost the same. This would reduce the expense of change to almost nothing if intelligently managed. New machines to replace old ones should be designed in the metric system. Those who have used both systems know that it is easier to design in the metric system than the other, so this will be a gain and not a loss from the start. The absurd way, that no intelligent engineer would adopt, would be to throw everything away that was not metric. The way it was actually done in the countries which successfully made the change was to keep tools and machines until worn out or discarded for other reasons. Having for twenty years a full working knowledge of the superiority of the metric over all other systems, I hope your Government, otherwise so progressive, will adopt it without delay.

VICTOR PINGRET, *Engineer.*

THE UNITED COKE AND GAS COMPANY,
New York City, April 4, 1906.

Mr. J. H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures,
House of Representatives.

DEAR SIR: In reply to your letter of the 31st ultimo, I sincerely regret my inability to address your committee on the subject of the adoption of the metric system by the Departments of the United States as requested by you.

As I have already written, the notice was insufficient for me to rearrange important matters, to which I was already committed, and my hope that they might still be adjusted so as to leave me free has been disappointed.

I am strongly in favor of this bill, however, and in default of a personal appearance before your committee, beg leave to submit a short written statement of my reasons for advocating its adoption.

It seems to me almost inconceivable that a nation that has for over a hundred years enjoyed the benefits and conveniences of a decimal coinage system should still need agitation and education to convince it of the need for placing all its standards of measurement on a decimal basis. With the example before us of our great English-speaking fellow-nation laboring under the incubus of a duodecimal monetary system, which its largest colony, Canada, has long since abandoned, it is hard to understand the narrowness of vision that perpetuates the old order.

As has already been stated by your chairman, scientific men, and those engaged in educational work throughout the country, are practically a unit in advocating the adoption of the metric system. To them the saving of time is an important matter, and most of the first named have already adopted it for their everyday work, while those who have to do with the work of our schools and colleges can measure in hours and days the time lost in learning and practicing a faulty system, and realize, perhaps, most clearly the need of reform.

The principal objection to the change, or to the prospect of change opened by the passage of the bill in question, seems to come from some individuals in the class of men to whom it would ultimately be of the most benefit, namely, those engaged in engineering and manufacturing; the civil engineer, who should remember his annoyance in transferring square feet to acres, or transforming his elevations—read in feet and tenths on the leveling rod—to inches to suit the brick mason's rule; the mechanical engineer, forgetting the time so often wasted in estimating the size tank to hold a given number of United States gallons; or the manufacturer, appalled by the fear that he must discard the special tools and appliances adapted exclusively to the inch, and unmindful of the fact that the markets of the world, to which he must sooner or later send his wares, are coming rapidly to the metric system where it is not already adopted.

Indeed, to many in the engineering and mechanical professions the duodecimal ratio of inch and foot seems to have a sort of fascination. They have never used a unit that was not divided by vulgar fractions, and they can not conceive of doing so. Yet the decimal division has forced its way all through the engineering profession, and among well-trained mechanics the 0.001 of an inch is no longer a mystery.

The greatest argument for the passage of this bill now is the economy of it. The metric system has forced its way into use in practically all except the English-speaking countries. Its fancied defects have not hindered the mechanical development of the Germans or the French, who are both able to show us achievements worthy of their pride and our admiration.

Practical uniformity is bound to come, at whatever cost. And the cost of the change will never again be as little as now. It is a disgrace to a business-like and farseeing nation that we have waited so long.

Yours, very truly,

DR. F. SCHNIEWIND,
Vice-President.

THE GAS MACHINERY COMPANY,
Cleveland, Ohio, April 18, 1906.

JAS. H. SOUTHARD,
Chairman Committee on Coinage, Weigths and Measures,
House of Representatives.

DEAR SIR: Having been in the construction business for three years in Germany, and worked actively under the metric system, I wish to state that it is the easiest system to learn, the most convenient to use, and is also liable to less errors in practice than any other system of weights and measures.

The change from one system to another is made with far less difficulty than would appear at first sight and very little confusion arises when the metric system is first put into use.

It is with pleasure that I submit the above to you, and I trust that the metric system may soon be properly introduced into the United States.

Very respectfully, yours,

THE GAS MACHINERY COMPANY,
W. E. STEINWEDELL, *Secretary.*

Thomas S. Crane, engineer and patent expert, of No. 70 Nassau street, New York, N. Y., said:

In 1876, when the Centennial Exposition was held in Philadelphia, I was a manufacturer of machinery, and my attention was attracted by an exhibit of metric weights and measures, and becoming interested, I purchased scales and diagrams showing the relation of the metric measures to the English measures.

I have studied, from time to time, how to substitute one of these measures for the other in building machinery; but in my own business at that date I found it impossible to do so from the fact that all of the supplies which I had to purchase, such as bolts, screws, taps, and especially bar iron, and steel, were made in English measures; and as I considered it impossible to use the metric measures in connection with these supplies, it proved impracticable to use the metric measures, or to use two different sets of measures in the same work.

I have always been convinced, however, that the use of the metric system was essential to successful competition with other nations, and am satisfied that the change to the metric system can be made without an entire loss of the tools and fixtures now in use.

Many of the present tools, such as reamers, gauges, and jigs for special construction can be adapted to the metric system with no great expense, as the changes for converting them into the metric measures would consist in grinding down the cutting edges of reamers, rose bits, flat drills, and other special tools to the next smaller metric size to which they approximate; and in the case of jigs and special fixtures furnished with bushings to guide drills and reamers in making interchangeable parts, the bushings may be ground out to a slightly larger size to suit the nearest larger metric measure, or, if preferred, the bushings may be removed and replaced with others of the next smaller size of the metric measure.

To facilitate the understanding of metric measures and their relation to the English measures which correspond most nearly, I

would, in making the change in any given workshop, place in the different workrooms (fastened upon large cards) representations in pairs of the same tool made in the English and metric measurements which most nearly approximated, and which could be substituted most conveniently for one another in the designing and construction of machinery.

Workmen and draftsmen accustomed to English measures could, by reference to this card, learn at any moment what was the nearest approximation for a given measure, to be used with the tools in their factory.

This object lesson would rapidly familiarize the workmen and draftsmen with the particular metric measurements which were substituted for English measures in the tools of their shop and thus enable each one, after a certain practice, to think in metric measures, and to realize with clearness the dimensions represented by the different metric terms.

Tables have long been used showing the English and metric equivalents, and these cards are not designed as a substitute for such tables, but to exhibit to the eye of the worker selective examples of the English and metric measures which are embodied in the tools and stock of materials with which he is expected to work, and the illustrations upon the card would thus rapidly familiarize him with the principal metric measures which he is expected to use.

The tools represented upon such card would be mere dummies made of wood, iron, or brass, and the following list is an illustration of those which could be embodied upon such a model card:

Dimensions of models, showing approximate size in millimeters to which existing tools can be reduced by slightly grinding them.

English measures.	Exact equivalent.	Can be ground down to—
Inch.	*Millimeters.*	*Millimeters.*
1/16	1.587	1.50
1/8	3.174	3.00
3/16	4.762	4.75
1/4	6.349	6.25
5/16	7.937	7.75
3/8	9.524	9.50
7/16	11.112	11.00
1/2	12.700	12.50
9/16	14.287	14.25
5/8	15.875	15.75
11/16	17.462	17.25
3/4	19.050	19.00
13/16	20.637	20.50
7/8	22.225	22.00
15/16	23.812	23.50
1	25.390	25.00
1 3/16	30.15	30.00
1 7/16	36.50	36.50
1 15/16	49.20	49.00

[C. Jevne & Co., importers and grocers.]

CHICAGO, *April 12, 1906.*

J. H. SOUTHARD,
Chairman, Washington, D. C.

DEAR SIR: We take the liberty to urge upon you a favorable report on the Littauer bill of the metric system of weights and measures.

We believe that the adoption of the metric system would cause very little if any trouble, and when once established it would greatly simplify business. It is the best system in the world, and we sincerely hope it will be adopted in the United States.

Very respectfully, yours,

C. JEVNE & Co.

CHICAGO EDISON COMPANY,
Chicago, April 11, 1906.

Hon. JOSEPH CANNON,
Speaker, House of Representatives.

DEAR SIR: The Littauer bill, now pending before Congress, provides that the Government Departments, in the transaction of business requiring the use of weights and measures, shall use the metric system.

The purpose of this bill, as I understand it, aside from facilitating the work of these Departments by the use of the metric system, is to assist in gradually bringing this system into general use in this country.

As a member of several engineering societies, I have heard a great deal of discussion pro and con upon the advisability of the substitution of the metric system for the various other systems now in use, and have generally found that, while admitting the merits of the metric system, the opposition to its introduction is based upon the fact that we are using other systems now. I think, however, I can truthfully say that the majority of the engineers of the country would like to see the metric system adopted, not only in the Departments of the Government but in everyday commercial use as well.

The gradual introduction of this system into use in this country, as is contemplated by the Littauer bill, would, I believe, be favored by the Departments affected, and would bring the mass of the people to more clearly realize the great saving in the labor of calculations which the adoption of this system would bring about.

Trusting that you will also be inclined to favor the adoption of this measure, I am,

Very truly, yours,

W. L. ABBOTT,
Chief Operating Engineer.

[Bloomingdale Brothers, importers and retailers.]

NEW YORK, *April 12, 1906.*

Hon. J. H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures,
House of Representatives.

DEAR SIR: Had not important business engagements prevented, I should have taken much pleasure in appearing before your committee and calling attention to the need of a general reform in measurements as applied to textiles. It seems to me that the abuses in the marking

of textiles now on the market call for a general reorganization of the system of measurement, and that the adoption of the metric system would certainly be a common ground on which this much-needed reform could be conducted. At present it is the custom of certain textile manufacturers to label their goods with false measurements, thus creating much confusion and embarrassment on the part of the self-respecting retail dealers in their relation to their customers by constantly obliging them to make explanations that labeled measurements on certain lines of goods means nothing.

Take, for instance, the marking of blankets. The blanket which is called a ten-quarter blanket would appear to be, as it was originally intended to be, a blanket ten-quarters of a yard long, or 2½ yards. As a matter of fact, the application of the yardstick shows that a blanket so designated is only 2 yards in length. Tablecloths which are marked six-quarters are in many cases barely a yard in length. The severe competition among manufacturers has led to the shrinking of the blanket year by year in order to lower the price on the product. Many American manufacturers, as well as the English and Scotch, succeed by various subterfuges in giving the impression that their goods measure more than they do. An examination of the products of the mills of many maufacturers shows this same tendency. The retailer in his relations with the public is constantly obliged to explain that ten-quarters from a particular mill only yields 2 yards, and that good bearing the name of well-known manufacturers are often falsely designated and that as a matter of fact they do not measure up to their labels. The principle of caveat emptor does not apply in this case. The public has a right to expect that textile products shall measure exactly what they are marked.

In most every country any such false labels would be frowned upon by the authorities, as it is contrary to the laws of civilized countries to permit of any such contempt of honest measurements as is indulged in by many domestic manufacturers.

It seems to me that this is a serious matter and one which should receive the attention of the National Government. It might well call for the exercise on the part of Congress of its as yet unexercised prerogative of establishing weights and measures.

It may be urged by some persons that a statute fixing penalties for misrepresentation of the measurements of goods would be equally effective if it applied only to the old measures, but this does not take into account the existence of the many absurd traditions which have grown up under our present system of metrology.

Some manufacturers regard the English system as merely a string of meaningless symbols, and are inclined to call two yards and a half about anything which they please. The reputable retailer, meanwhile, must tell his customers to consider the measurements printed on the labels of certain merchandise as amiable fiction, and to take the article, if it is adapted to his needs, without any reference to the marks thereon.

The introduction of the metric system in such countries as Germany has resulted in habits of exactitude, and there the purchaser must get exactly what he is supposed to get. The present archaic system of weights and measures gives to certain unprincipled dealers a host of ingenious makeshifts which enables them to evade their obligations to give to the public a square deal.

It is time for a new deal, as far as textiles are concerned, and in my opinion I think that old traditions could be swept away and American metrology so established that the slipshod methods which obtain among a certain class of manufacturers and dealers could be abolished.

I am heartily in sympathy with the efforts of the Committee on Coinage, Weights, and Measures, and hope that they will result in much-needed reforms.

Very truly, yours,

SAMUEL J. BLOOMINGDALE.

NEW YORK, *April 13, 1906.*

Hon. J. H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures,
House of Representatives.

MY DEAR SIR: On April 2 last I received a request from you to appear before your committee on Wednesday or Thursday of that week. I telegraphed you that pressing engagements would not permit me to go to Washington that week.

I am now informed that your committee will receive written testimony on this subject up to to-morrow. I take advantage of this to briefly give you my views on the subject of the metric system.

It is unnecessary for me to go into the details of this question and to present the advantages of the metric system. I have no doubt this has been done by other advocates of the system who have appeared before your committee. I wish only to give you my opinion in favor of the passage of the bill, based on over a quarter of a century of experience with the metric system. My opinion has long been pronounced in favor of introducing that system into this country and abandoning the system we now have. The more experience I have had in engineering business in other countries, the more pronounced is that opinion. I believe very strongly the time has come for the adoption of a decimal system—that is, the metric system, so called, and what may be truly called now an international system.

I take it for granted that my opinion will have weight with you in accordance with the extent and importance of my experience, and I will briefly outline that experience. It began with a project for the Atlantic and Pacific Ship Railway, proposed by the late Mr. James B. Eads. I was the chief engineer of that project, and as such was a good deal of the time in Mexico for several years. I had charge of the surveys and much other work connected with that great project. Afterward I had charge, for the Mexican Government, of building an ordinary railroad across that isthmus. I built the Tampico jetties, on the Gulf of Mexico, and have had many other inportant relations with Mexico. I was for over two years, by recommendation of our Government, the consulting engineer of the Argentine Government, having to do with all of its important river and harbor works. I have been for the last year most of the time in Brazil, arranging for construction and operation of very large harbor works in that country. Since 1898, when I was appointed by Secretary of State John Sherman delegate to the International Navigation Congress at Brussels, I have been up to the present time a member of the council of that association, the principal office of which is at Brussels, and in which are representatives of the governments of twenty-

five countries. With this brief résumé of my connection with works, engineers, and governments of other countries, you will at once see that I have the right to have an opinion on the subject which is before your committee.

It would require more time than you have at your disposal for me to state the difficulties that I have encountered in my engineering works with other countries, on account of the radical differences in the systems of measurement. It is constantly converting back and forth. For instance, the report which I made to the Government on the Navigation Congress of 1898, being a large volume of 245 pages and 114 illustrations, and the report being issued as Senate Document No. 30, Fifty-sixth Congress, first session, required an immense amount of conversion work of all sorts of measures from the metric system, as they were expressed in about 70 papers written in French, into our system. This report was intended for circulation in this country and in England, and it was absolutely necessary to have the weights and measures stated in the two systems. This international system is simple, logical, and consistent in all of its details with the principles on which it is established. Computations of all kinds in respect to weights, measures, and volumes are made with the greatest ease, and I am satisfied that with the intelligence and education of our people, particularly the young, there will be no trouble whatever in introducing that system generally into this country. My opinion on this point is founded on investigations which I have made in other countries, where, being interested in the subject, I have made inquiries from time to time in Europe, in Mexico, and South America as to the difficulties experienced in the adoption of this system. None have been found anywhere worth making note of. In Switzerland three years ago I had an opportunity to look into this matter very carefully, as I had been told that there were considerable remains of the ancient system and that the old measures were still in use. I wrote a questionaire which I submitted to one of the leading government engineers, Mr. von Morlot. His reply was very definite and satisfactory, and I attach it to this communication for your information. You will get the same answer by referring the matter to prominent and well-known men in other countries.

I need not refer to the immense amount of printed matter issued both in this country and in Great Britain on this subject for confirmation of my statements and views.

I only wish to confirm the views of other advocates of the adoption of the use of this international system by referring to my very long and important experience in connection with the subject.

I am, yours, very truly,

E. D. CORTHELL,
Civil Engineer.

[Translation.]

BERN, *August 30, 1903.*

Mr. E. L. CORTHELL,
Civil Engineer, Felsenburg, Bern.

DEAR SIR: In answering your questions about the matter of the metric system, I have the honor to state:

Q. When was the metric system first introduced, and when was it made obligatory?—A. By the law of the 14th of July, 1868, the metric system was made permissive, and by the federal law of the third of July, 1875, made definite; the latter was made obligatory on the 1st of January, 1877.

Q. Was it very difficult to introduce it?—A. No; it gave very little trouble.
Q. Is it absolutely obligatory over the whole Republic?—A. Yes.
Q. What were the principal former weights and measures?—A. See conversion table (Exhibit I).
Q. Are any of the old weights and measures still in use in the country districts?—A. Very seldom do you hear about old weights or measures; you do not meet them any longer in business transactions.
Herewith I send you a copy of the federal law, which gives instructions to the inspectors of weights and measures. (See Exhibit II.)
Hoping this will be of use to you, A. VON MORLOT.

[Milliken Brothers (Incorporated), civil engineers and contractors in iron and steel construction.]

NEW YORK, *April 4, 1906.*

HON. J. H. SOUTHARD,
Chairman committee in charge of
Littauer metric bill, Washington, D. C.

DEAR SIR: Referring to metric bill before Congress, we received a telegram from you to-day, reading as follows: "Would like to have representative of your firm give House committee your views on Littauer metric bill Thursday, 10 o'clock," to which we immediately sent you an answer, as follows: "Telegram received. Impossible have representative there to-morrow. Please send copy of bill; let us know when next hearing takes place," all of which we now beg to confirm.

In the first place, we do not happen to have a copy of this bill at our office, and would like to know all of its terms and conditions before stating definitely what our views are on this subject.

We regret to say that it is impossible for us to have a representative there to-morrow morning, as the notice is too short. We would, therefore, like you to advise us when the next hearing will take place, and we will try and have some one represent us before your committee.

Generally speaking, we are strongly in favor of the metric system being adopted by this country for weights and measures. We do a very large export business in structural steel and iron work, probably the largest in this country, if not in the world. We believe we were the first company to publish extensive catalogues in four languages, namely, English, French, German, and Spanish, in which all of the dimensions of the products which we make and all the tables relative to the strength of same were given in both English and the metric system of weights and measurements. Compilation of the tables probably took six or eight months, as they are very extensive. It was necessary for us to do this, because in our foreign business we were obliged to use the metric system.

We have found that this system, while not perfectly understood by most of our draftsmen on the start, is now well understood by most of them, and after they once understand it they much prefer to work with it rather than the English system.

We believe that if the metric system were universally adopted in this country it would save us thousands and thousands of dollars per year in making our detail shop working drawings. The use of feet and inches and fractional parts of an inch are very confusing and very difficult to quickly calculate and check, which is not the case with the metric system.

We are taking the liberty of sending you, under separate cover, by this mail one of our English edition catalogues, so that you can see the tables which we have above referred to.

If you desire our views to be given orally before your committee, we sincerely trust that there will be another hearing, and if you will give us sufficient notice we will do our best to have a representative present, as we are very much interested in seeing the metric system adopted by this country, providing, of course, that there is nothing in the bill that we would object to.

Very truly, yours,

MILLIKEN BROS. (INCORPORATED).

[The Vacumn Varnish and Chemical Company, Incorporated, chemical manufacturers.]

EAST NORWALK, CONN., *April 12, 1906.*

Hon. J. H. SOUTHARD,
Chairman Committee on Coinage,
Weights, and Measures, House of Representatives.

MY DEAR SIR: Will you kindly permit me to be "one more" of those who are urging the adoption of the metric system as the system to be adopted by the United States as its standard of measurement.

My introduction to it dates some thirty years back, to my school days. Later I used it in the chemical laboratory in my university, and have used it in laboratory work ever since.

On January 21, 1906, I wrote to the New York Herald stating my interest in its adoption, also that I proposed to quote future prices of my products in accordance with this system. I inclose a simple advertising card and price list which I am sending to my customers. Many manufacturers could do this same thing without inconvenience, and soon certain classes of goods would be entirely sold by this method.

As long as this system is surely to be adopted, and this very few will attempt to deny, why will some time in the dim future be more expedient than the present, giving, of course, sufficient time for change to take place?

We are buying by the "kilo;" why not sell by the same?

Its convenience, its economy—for it certainly means less clerical work to the manufacturer—its appreciation by those who buy from us abroad, all, it seems to me, more than outweigh the temporary inconvenience of changing, even under the most complex systems of manufacturing.

Permit me to urge, as strongly as a small manufacturer may, the adoption of this system.

I am, with much respect, yours, truly,

HOMER CLARK.

[Hamburg-American Line, 35 and 37 Broadway, New York.]

APRIL 3, 1906.

Hon. J. H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures,
House of Representatives.

DEAR SIR: I received your favor of the 2d instant, and as I wired you to-day, I regret to say that, having just returned from a business trip, it is impossible for me to leave New York at present and attend the hearings, although I should have liked very much to give my oral testimony as to the advantages of adopting the metric system of weights and measures.

The United States and Great Britain are the only civilized nations which still adhere to the archaic system of weights and measures based largely on the rule of thumb. This system is antiquated and cumbersome, making calculation difficult and entailing a great amount of unnecessary work. Just compare the complicated computation necessary, for instance, to multiply any quantity taken at random, say, 7 pounds 8 ounces 9 drams with any number, with the simplicity of performing the same operation with the approximate metrical equivalent of 3.418 kilograms.

Or, say, the measure of distance of 1 mile 3 furlongs 27 rods 4 yards 2 feet and 9 inches should be squared and compare it with squaring the approximate metrical equivalent of 2.353 kilometers.

Or take the dry measure quantity of 7 bushels 3 pecks 6 quarts and ½ pint, or the same quantity in liquid measure of 1 hogshead 10 gallons 3 quarts 1 pint and 3 gills and compare it with the simplicity of the metric equivalent of 280 liters!

The metric system is so convenient, simple, and accurate that it adapts itself easily to affairs of everyday life.

An adherence to the old system divides us off from all other civilized nations who have adopted the convenient metric system. Weights and measures expressed in this system are at once understood by all these nations, and in using these terms a universal language is employed. I spend some time in Europe every year, and time and again when inquiry was made on the continent of Europe with regard to machinery, carriages, and a multitude of other things successfully manufactured in the United States, and when weights or dimensions were given in English terms annoyance was expressed that the information was not readily intelligible and had to be transformed, while any similar data given for French articles, for instance, would at once be understood in Germany or any other continental country.

Attention has been called to the fact that Great Britain is our best customer, and that we should, therefore, not change our weights and measures unless England does so at the same time. I beg, however, to point out that Great Britain is a manufacturing nation and takes from America to a very large extent raw products and staple articles which it also imports from other countries; that they come in large shipments where the question of weights and measures is not so important, and that Great Britain very strenuously competes with America in the markets of the world for manufactured articles, where the universal language of metric weights and measures is a distinct advantage. Great Britain's total imports in 1903 were about 543 million pounds sterling, of which approximately 367 million pounds sterling were for food and raw materials; her exports in the same year amounted to about 290 million pounds sterling, of which 235 million pounds sterling, or over 80 per cent, represented manufactured articles.

I am perfectly sure that the adoption of the metric system of weights and measures will facilitate America's intercourse with foreign nations and benefit American industry.

Yours, very truly, EMIL L. BOAS.

To the honorable Senate and House of Representatives of the United States in Congress assembled:

The New York Academy of Sciences, of New York City, in the State of New York, respectfully submits the following resolutions advocating the substitution in the United States of the metric system of weights and measures for the diverse and cumbersome standards now in use:

Whereas the metric system has already been adopted by all civilized countries, with the exception of the United States and the British Empire;

Whereas it is a simple, uniform, exact, and widely known system of weights and measures based on a decimal ratio harmonizing with our decimal system of currency;

Whereas our foreign commercial relations will be greatly benefited by the adoption of the system which is in use in many other nations; and

Whereas the metric system of weights and measures has been universally adopted for scientific work in other nations as well as our own; Be it

Resolved, That the New York Academy of Sciences respectfully urges that a law be enacted making the metric system of weights and measures compulsory in all departments of the Government of the United States in which the transaction of business requires the use of weight and measurement.

[American Institute of Electrical Engineers, White Building, 95 Liberty street.]

NEW YORK, *May 5, 1906.*

Hon. J. H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures.

DEAR SIR: I have the honor to inform you that in order to ascertain the attitude of the A. I. E. E., the report of the standardization committee, in the form of the inclosed resolutions, was submitted April 5 for letter ballot to the associates and members residing in the United States, numbering about 3,300. The returns up to May 5 were as follows: In favor of resolutions, 1,569; against resolutions, 178; total vote, 1,747. This vote is not to be considered as the official action of the institute, but simply as showing the views of the members who were sufficiently interested in the matter to cast a vote.

I have been authorized by Dr. Schuyler S. Wheeler, president, to transmit to you the above information.

Yours, truly,

RALPH W. POPE, *Secretary.*

[American Institute of Electrical Engineers, New York, N. Y.]

NEW YORK, *April 5, 1906.*

To members and associates of the American Institute of Electrical Engineers:

The following preamble and resolutions concerning the "metric system" were favorably reported to the board of directors by the standardization committee at the directors' meeting of March 23, 1906. In view of the importance of the questions involved and the possibly differing views of the membership at large, the board decided to submit the matter to the membership for a letter ballot. It is proposed to transmit the result of this ballot to the Congressional Commitee on Coinage, Weights, and Measures before May 1:

Whereas the metric system of weights and measures offers very great advantages by its simplicity, consistency, and convenience in everyday use, as well as in engineering and scientific calculations and computations; and

Whereas these advantages have already been demonstrated by the universal adoption and entirely successful use of the metric system in all civilized countries except Great Britain and the United States; and

Whereas all the electrical units in universal use, such as the volt, ampere, ohm, watt, etc., are metric units; and

Whereas the industrial use of these electrical units would be much facilitated by the general adoption of the metric system:

Resolved, That this committee unanimously recommends the introduction of the metric system into general use in the United States at as early a date as possible without undue hardship to the industrial interests involved.

Resolved, That this committee favors such legislation by Congress as shall secure the adoption of the metric system by each Department of the National Government as speedily as may be consistent with the public welfare.

F. B. CROCKER, *Chairman*.

February 27, 1906.

Kindly tear off and return at once one of the ballots printed below.

Yours, respectfully,

RALPH W. POPE, *Secretary*.

NEW YORK, *April 4, 1906*.

HON. JAMES H. SOUTHARD,
Washington, D. C.

DEAR SIR: Permit me to thank you for your kind invitation to appear before the committee to-morrow regarding the metric system. I regret very much that on so short a notice I am unable to arrange my business so as to be present.

The advantages of this system are many, and have been much better stated than I can state them. Any system which is a multiple of ten would produce the same result. This system has been thoroughly tested by France and Germany and found of immense value. Any child can manipulate it as easily as our pennies, dimes, and dollars, after it is once thoroughly understood and comes in general use. The great amount of time and labor saved by those whose business is the manipulation of money, by the use of our system over the English, and the ease with which this money system is understood and used by everybody, is very apparent. Any banker, bookkeeper, or business man would think it idiocy to return to pounds, shillings, and pence.

This same saving of time and labor would apply to every line of business which has to deal with calculations involving yards, feet, and inches, and fractions of an inch where the calculations must be made each time to enable them to turn out their finished product, such as buildings, excavations, steel construction, or any construction in which the operation to produce the finished product is repeated many times.

Once understanding this system, it would be handled by the general public as easily as it handles our money. The conduct of our export trade would be much facilitated, and our custom-house saved a great quantity of labor. Should you so desire I can readily go into detail regarding the saving in building construction work.

The objection to the adoption of this system is all connected with the confusion and expense of making the change. This objection is made by a number of manufacturers. In the paper issued by the

National Association of Manufacturers the objecting members all come from those who manufacture standards. The change would be of no particular benefit to them excepting as a part of the general public, and would be attended with some confusion and expense, which seems to be naturally greatly overestimated. It would not necessarily mean that these manufacturers made over all their standards, but it would mean their designating them by some name applicable to the metric system, and from time to time changing them to meet the requirements of that system. It would seem as if this might turn out much less confusing and expensive than first expected.

A number state that they would withdraw from Government work. I think it has been the experience of everybody that we have plenty of people to sell and only wish there were more to buy, and that it is comparatively easy under any conditions to obtain any article if one only has the money to pay for it. That statement would hardly seem, therefore, to carry much weight or be at all alarming.

A certain amount of confusion would also result in teaching mechanics to use the new system. This has been proven to be small by the German Government.

If every 2-foot rule in the country were destroyed at one time and a rule one-half or three-fourths of a meter long, graduated into decimeters, centimeters, and millimeters, be substituted, and each centimeter numbered 1, 2, 3, 4, as inches are numbered now, any mechanic using this rule and working from a drawing giving all dimensions in divisions on this rule as units, would master the system, as far as laying off work was concerned, in a few days, and in a few weeks, after he had begun thinking in centimeters and meters instead of feet and inches, he would have no further difficulty.

After further trial, when he found that all of his calculations consisted in multiplying or dividing by 10 or simply moving a decimal point one way or the other across a line of figures, not only would he begin to see the advantages, but the country would lose a lot of lightning calculators in mental arithmetic.

The main point to decide is whether the loss and inconvenience to these manufacturers of standards and the temporary inconvenience to the general public is offset by the advantage to the public of a simple and better method of weights and measures and the saving in labor to all constructors, contractors, engineers, and special manufacturers, as well as to the United States custom-house and our foreign trade. As no manufacturer sells his product at a loss if he can help it, the cost of the change would eventually be borne by the general public, who, not being much affected directly, either one way or the other, are probably on that account rather apathetic.

I trust I have not taken up too much of your valuable time, and that my communication may be of some service to you.

Very respectfully, yours,

W. H. GOULD.

[Reprinted from School Science, December, 1901.]

PARTIAL USE OF DECIMAL SYSTEM THIRTY-FIVE YEARS AFTER LEGALIZATION.

The process of transition to the use of Federal money, inaugurated by resolutions of the Congress of the Confederation July 6, 1875, and August 8, 1786, was protracted through the time of our grandfathers, the generation following that which established the money. Kelly's Universal Cambist, whose preface is dated in 1821, thirty-five years after the original legislation, is a standard authority, having had official support. It said of the United States:

Accounts are kept here in different ways, but chiefly in dollars, which are divided into 10 dimes, 100 cents, or 1,000 mills. This is called Federal money, to distinguish it from the various currencies which were formerly the moneys of the United States, and which are still partially retained in domestic traffic, etc.

The constitution of Massachusetts said then, and says now, in Chapter VI:

III. In all cases where sums of money are mentioned in this constitution, the value thereof shall be computed in silver, at six shillings and eight pence per ounce, etc.

The United States Mint, though it began to coin money in 1793, did not strike many coins except cents, half cents, and half dollars down to 1820, and coins of the several nations of western Europe continued in circulation. The Spanish original of our dollar was well known as the "piece of eight," meaning 8 "bits" in the vernacular tongue of the United States, where the Spanish name is less familiar; 1 bit thus becomes 12½ cents obviously to us, but our grandfathers knew it is of the value expressed according to their long-established custom in their different monetary reckonings. John Quincy Adams, Secretary of State, in his celebrated report on weights and measures, also dated in 1821, wrote as follows:

*** * * Now, when the recent coinage of dimes is alluded to in our public journals, if their name is mentioned, it is always with an explanatory definition to inform the reader that they are 10-cent pieces; and some of them which have found their way over the mountains, by the generous hospitality of the country, have been received for more than they were worth and have passed for an eight, instead of a tenth part of a dollar. Even now, at the end of thirty years, ask a tradesman or shopkeeper in any of our cities what is a dime or a mille and the chances are four in five that he will not understand your question. But go to New York and offer in payment the Spanish coin, the unit of the Spanish piece of eight, and the shop or marketman will take it for a shilling. Carry it to Boston or Richmond and you shall be told it is not a shilling but 9 pence. Bring it to Philadelphia, Baltimore, or the city of Washington and you shall find it recognized for an 11-penny bit; and if you ask how that can be you shall learn that the dollar being of 90 pence, the eighth part of it is nearer to eleven than to any other number, etc.**

This was characterized by Mr. Adams as absurd, and justly. Oh, yes. But, by the way, what is it that we are doing A. D. 1901, thirty-five years after the inauguration by our fathers by the act of Congress of July 28, 1866, of the change to metric weights and measures? Our rates of postage on foreign mail matter are by weights in grams, and we try to look them up in pocket diaries or other common places of reference and find them inaccurately stated by weights in ounces. We turn to the Revised Statutes of the United States, section 3515, referring to our minor coins, and read, "The weight of the piece of

5 cents shall be 77.16 grains troy"—a circumlocution for 5 grams. We have had profile paper printed with metric subdivisions for its whole length and have measured it off in portions for sale by the yard. Imported paper in rolls of 10 meters we have advertised as 11-yard rolls. These few examples suffice out of many instances of misapplication of units of quantity in business and in publications.

We see the unreasonableness both of the Massachusetts constitution and of the adherence by our grandfathers, so long after they had established decimal reckoning, to their antiquated bookkeeping, which occasioned great inconvenience from the incongruity of the two methods in use at the same time. When our grandchildren look back to 1901, what will they say of our now hanging on to weights and measures that are out of date by consequence of the substitution of the metric units legalized thirty-five years ago?

Consider electricity, whose standards of measurement are fixed upon a metric basis by the law of July 12, 1894. The following is an extract from it:

> The unit of power shall be the watt, which is equal to 10,000,000 units of power of the centimeter-gram-second system, and which is practically equivalent to the work done at the rate of one joule per second.

Several of the electrical units have become familiar to us through the enormously rapid development of the applications of electricity. This is the case especially with the kilowatt, a commercial unit which we meet with in almost every technical publication we take up; but it has not yet entirely displaced that anomalous old unit, the horsepower (as to which reference may be made to Engineering, vol. 63, pp. 245 and 325, for February 19 and March 5, 1897).

Consider the matter of assaying and coinage, in which the metric system is established. It has been used in the Mint for years, and is used in published tables or schedules of coins. The United States subsidiary silver money weighs 1 gram per 4 cents, and thus metric weight is in everybody's pocket. The troy pound has dropped out of practical use. Nevertheless, the troy ounce, incongruous as it is with other weights and measures, still comes in our way sometimes (in other places besides the Massachusetts constitution).

Consider pharmacy and some other matters connected with chemistry. The United States Pharmacopœia, the reference manual of the apothecary, is exclusively metric. The Dispensatory, the corresponding manual of the physician, has metric values throughout. The use of the metric system was introduced in the United States Marine-Hospital Service about a quarter of a century ago quite thoroughly, and in the Army and Navy more recently. In practice in civil life prescriptions are to a large and increasing extent written in metric terms; but the mysterious old "apothecaries'" weights and measures (which for sales of candy and popular wares are not used by apothecaries) continue to be used in the prescriptions of some of the older physicians, who in the natural course of events are gradually passing off the stage. Meanwhile pharmacists have double sets of weights and measures, and employ clerks who understand both, with extra trouble, cost, and risk of mistake. In the sale of high-grade chemicals the metric system has been introduced. E. R. Squibb & Sons, of Brooklyn, have used it exclusively for nine years, and the Bausch & Lomb Optical Company, of Rochester, issues a 60-page priced cata-

logue "G" of "Chemicals and reagents" in metric terms, with a conspicuous notice at the top of each page: "Prices of chemicals are by metric, not avoirdupois weight." Much glassware and rubber stoppers are made to metric scale. As to chemical manufacturing, all the tanks in a factory built by the Merrimac Chemical Company, of Massachusetts, for their extensive sulphuric acid works were made on metric dimensions, and the Pennsylvania Salt Manufacturing Company have built a large plant entirely upon metric dimensions. The great Solvay Process Company, of Syracuse, makes use of the metric system in every way possible in its works. Drawings to go outside of the works for construction, etc., are not made in the metric system. The company says it finds no disadvantages, and would be very glad if its entire work could be upon the metric system. That means that as long as people outside cling to ancient weights and measures, so that conformity with them is required of the Solvay Process Company, the company gets only part of the advantages naturally belonging to its system. Chemical analyses are expressed in parts per million, per hundred thousand, or per thousand, corresponding to grams per cubic meter, per hectoliter, or per liter. Grains per gallon are out of date. Nevertheless, in dealing with quantities and consumption of water there still lingers some use of the United States liquid gallon, a unit long ago abandoned in Great Britain and Canada, distinguished for its lack of connection with other measures or weights, and not ordinarily used in the reading of water meters.

Consider geodesy and precise leveling. The metric measure has been very extensively used in precise leveling or other work of the United States Coast and Geodetic Survey, the United States Geological Survey, the United States Lake Survey, and the surveys under the Mississippi River Commission. Among other literature from which evidence may be obtained about this, and about working in old measures incongruous with metric, there is an article and discussion on "Precise spirit leveling," occupying pages 1–206 of volume 45 of the Transactions of the American Society of Civil Engineers, June, 1901.

Bulletin No. 26 of the United States Coast and Geodetic Survey, dated April 5, 1893, contained an announcement signed by T. C. Mendenhall, superintendent of standard weights and measures, and approved by John G. Carlisle, Secretary of the Treasury, from which the following is an extract:

> * * * The office of weights and measures, with the approval of the Secretary of the Treasury, will in the future regard the international prototype meter and kilogram as fundamental standards, and the customary units, the yard and the pound, will be derived therefrom in accordance with the act of July 28, 1866. Indeed, this course has been practically forced upon this office for several years, etc.

The Treasury Department is the Department to which are attached the Mint, the Marine-Hospital Service, and the Coast and Geodetic Survey, in all three of which, as above stated, the metric system has been in practical use for years. Incongruity is found, however, in the fact that the Treasury Department continues the use of old weights and measures in other branches of its work—for ex-

ample, in its Bureau of Statistics, largely occupied with foreign trade (whereas metric units have been introduced to some extent in the Bureau of Foreign Commerce of the State Department and in the section of foreign markets of the Agricultural Department), and, for another example, in the customs service, where there will be special gain in the substitution of the international system and where its substitution has been repeatedly urged, officially and unofficially.

Consider manufactures. The April, 1900, report of the American Railway Association's committee on the metric system enumerated among manufactures in which the metric system has been introduced watches, injectors, refrigerating apparatus, screw-cutting lathes, scales, drills, gauges, astronomical and physical instruments, measuring implements, and draftsmen's supplies. A very large number of manufacturers have had some call for the application of metric measurement for goods for export, if only on a small order, and goods of widely diverse character among the metric manufactures. We have exported to metric countries a deal of ordnance and machinery for manufacturing ordnance, and rapid-firing guns have been designated by their caliber in millimeters. The Baldwin Locomotive Works' illustrated catalogue of narrow-gauge locomotives has printed on its title page, "Adapted especially to gauges of 3 feet 6 inches, or 1 meter," and on each of the 16 pages (108–138), on which are tabulated various types of locomotives, has printed conspicuously, "Gauge, 3 feet 6 inches, or 1 meter." The library bureau, of Boston, has cards and cases made of exact metric dimensions. In the Electrical Review (New York) for June 22, 1901, George H. Draper says:

> There is no first-class shop in America that will not undertake to build machinery according to metric measurements, and many of them are at the present time compelled to build stock forms of machinery in measurements of this system in order to be able to compete for trade in foreign countries where the specifications are given in round metric terms.

The following sentences are quoted from the American Manufacturer:

> The metric system is making some headway among American manufacturers engaged in the export trade. This is especially true of machinery builders. It will continue to make headway according to the increase of our exports.
>
> * * * * * * *
>
> There are firms that have adopted the metric system for their export business. They do not seem to be suffering from the effects of having two sizes of templates and dies for their plants. They are filling orders for export, and are teaching their workmen the use of the metric system in so doing.

The incongruity of having two sizes, whether there seems to be suffering from the effects or not, continues until the superseding in domestic trade also of old weights and measures by metric. A similar remark may be made in regard to United States importations of bottled goods, textiles, and other manufactures from foreign countries where the metric system is in use.

Consider bodily measurements, etc. The stature and strength of athletic young men in the colleges in different parts of the country are recorded in metric units and are published, but sometimes the newspapers, instead of recognizing the kilos, call them "points." Dimensions of statuary, etc., have been given metrically in the reports of the Boston Museum of Fine Arts regularly for many years. There

is great convenience in measuring the clothes as well as the body in centimeters not requiring fractions, and among men's furnishing goods some suspenders may be found with the length marked upon them in centimeters, but there remains in principal use for the measurements of tailors and dressmakers, and for sizes of such things as gloves and hats, the old unit with the ubiquitous fraction.

Consider applications of science. The metric system has been thoroughly adopted for scientific research upon all subjects and for the diffusion of scientific knowledge by publications and educational institutions. The extent of its use for instruction, laboratory supplies, apparatus, etc., is enormous; yet when scientific knowledge is utilized in technical work or for commercial purposes it often happens that old units of measurement are employed; so we have the incongruity of preaching one thing and practicing another, of producing certain effects with one measure in investigation and with another measure in business. Such complications are now a characteristic feature in our literature, the discussions of our professional organizations, reports of committees of research, periodical publications, or books of the day. Similar complications are common in shops, offices, and practical work, a fact so familiar as to require little illustration. Fineness of sand is expressed by the millimeter, and fineness of the sieves and screens for it by the number of meshes per inch. It is by the cubic centimeter of water that the number of bacteria are reckoned in biological examinations, but, rather than say so, men otherwise intelligent have sometimes disguised it for the popular mind as "thimbleful." Opticians have adopted metric measure, and, besides whatever else they have done in regard to their apparatus and accessories for microscopy, etc., they have a metric basis for expressing the power of lenses of spectacles. Their "dioptrics," depending on the focal length in meters, are found in the optician's price list; yet it is not uncommon to express the diameters of lenses in old measure, which may be found even in the same catalogues that give generally the metric system.

It is needless to marshal further evidence. The cutting off of the dog's tail is by centimeters, so that the tail may continue in some measure to wag the dog as long as he likes to have the operation protracted.

BOSTON, MASS., *April 14, 1906.*

Hon. JAMES H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures,
House of Representatives.

DEAR SIR: I have been writing letters to several Members of Congress of my acquaintance in advocacy of the passage of a bill for the introduction of the metric system of weights and measures, and I think it best now to inform you about this little effort of mine by putting together some pieces of what I have written to others. It has been my thought to make an argument which might appeal to persons whose preconceived opinions were not favorable to vigorous action toward metric reform. I send you herewith a few copies of some printed matter bearing upon the subject.

I should like particularly, if you deem it worth while, to have this letter shown Hon. William C. Lovering, the Massachusetts member of your committee, to whom I sent under date of February 2, 1906, a brief note containing the suggestion that I might write further if desired. He replied politely, assuring me that he should gladly give the matter most careful study and consideration when it came before the House.

I was for a number of years, between 1875 and 1884, a member of a committee on weights and measures in the Boston Society of Civil Engineers. My profession is that of civil engineering. I was for two years in charge of a locating party on the Mexican Central Railway and surveyed by metric measure. Two years ago I was president of the Boston Society of Civil Engineers and am now secretary of the board of managers of the Association of Engineering Societies, a combination of a number of local clubs who maintain a joint publication of technical papers.

I presume you are sufficiently acquainted with the arguments for the metric reform (intended to be embodied in accompanying chart), so that it may be superfluous for me to discuss them, unless you should signify a desire to hear from me about them. I regard it as no longer a question of weighing the merits of different weights and measures. What I ask you to notice is rather that the metric system of weights and measures, whatever is to be thought of the arguments supporting it, has in fact become firmly rooted, not merely in other parts of the world, but even in the United States; and that it is high time that energetic steps should be taken to obtain the real benefits which are to be had from it by getting rid of the confusion which now exists by the use of old customary weights and measures, which, whatever may be said for them, are certainly incongruous with the metric. I inclose herewith a little pamphlet which I prepared a few years ago, in which I undertook to point out a number of uses for which metric measure has become established and to compare the state of things with the earlier conditions in the introduction of the Federal money, the purpose being to show that it is requisite now to obtain the full benefit of the metric system by getting rid of the surviving use of incongruous ancient weights and measures, as truly as it was requisite in the last century to get the full benefit of decimal money by getting rid of the lingering use of pounds, shillings, and pence. I ask your particular attention now to the fact that a change has been and is going on in regard to our foreign commerce, which has great significance in regard to the custom-house business of the United States, I have taken the summary of imports and exports of the United States as tabulated from year to year in the World Almanac and doubtless obtained from the statistics of the Government. I have divided the countries into two classes, according to whether they have adopted for customs service metric weights and measures or not, and have added up separately the imports and exports, showing that the greater part of the foreign trade of the United States as thus estimated is now with the countries that have adopted the metric system for customs service.

[From The World Almanac and Encyclopedia, 1904.]

Value of imports into and exports from the United States of merchandise, year ended June 30, 1903.

[Countries in italics have not adopted the metric system.]

Countries.	Exports.	Imports	Countries.	Exports.	Imports.
Austria-Hungary	$7,209,855	$10,578,702	Argentine Republic	$11,430,496	$9,463,832
Azores and Madeira Islands	369,405	16,588	Bolivia	49.107	1,500
Belgium	47,073,160	22,766,830	Brazil	10,738,748	67,216,348
Denmark	16,144,935	600,193	Chile	4,038,875	9,377,313
France	77,542,436	91,060,702	Colombia	4,293,295	4,184,149
Germany	193,555,495	119,837,908	Ecuador	1,353,162	1,726,851
Gibraltar	*427,005*	*6,471*	Guianas:		
Greece	330,544	1,326,935	*British*	*1,936,524*	*3,351,656*
Greenland, Iceland, etc.	508	100,606	Dutch	555,398	874,454
Italy	35,022,660	36,368,860	French	351,262	215,811
Malta, Gozo, etc	*453,529*	*20,043*	Paraguay	13,021	2,887
Netherlands	78,245,419	22,710,673	Peru	2,971,411	2,703,643
Portugal	3,652,194	3,488,185	Uruguay	1,505,100	2,981,632
Roumania	256,927	6,554	Venezuela	1,878,202	5,312,954
Russia, Baltic, and White Seas	*13,399,370*	*7,731,441*	*Aden*	*1,508,999*	*2,328,654*
Russia, Black Sea	*2,723,258*	*1,508,341*	*British China*	*1,670*	*22,355*
Servia		25,263	*Chinese Empire*	*18,603,369*	*26,769,612*
Spain	17,626,084	8,474,528	*Russian China*	*681,756*	*1,655*
Sweden and Norway	10,160,874	4,905,234	*East Indies:*		
Switzerland	205,647	21,183,378	*British*	*4,795,411*	*49,774,589*
Turkey in Europe	496,785	5,672,578	Dutch	1,194,510	16,277,606
Great Britain and Ireland	*524,691,638*	*191,666,505*	French	131,692	10
Bermuda	*1,327,626*	*592,107*	*Hongkong*	*8,780,741*	*1,355,444*
British Honduras	*868,578*	*376,967*	*Japan*	*20,921,862*	*44,142,562*
British North America:			*Korea*	*171,400*	
Nova Scotia, New Brunswick, etc	*7,639,179*	*10,375,215*	*Russia, Asiatic*	*802,428*	*28,230*
Quebec, Ontario, etc	*109,828,167*	*37,942,258*	Turkey in Asia	276,247	4,897,428
British Columbia	*6,005,070*	*6,342,937*	*All other Asia*	*77,004*	*212,268*
New Foundland and Labrador	*2,509,415*	*868,238*	*British Australasia*	*32,748,580*	*6,969,017*
Central American States:			*British Oceania*	*98,669*	*2,087,812*
Costa Rica	1,858,604	3,731,523	French Oceania	398,169	579,457
Guatemala	1,128,045	2,400,063	German Oceania	120,041	25,442
Honduras	956,193	1,373,131	*Guam*		
Nicaragua	1,399,696	1,862,217	Philippine Islands	4,038,909	11,372,584
Salvador	797,253	891,987	*All other*	*3,668*	*10,049*
Mexico	42,227,786	41,254,542	*British Africa*	*35,788,629*	*971,908*
Miquelon, Langley, etc.	191,150	18,668	Canary Islands	815,463	42,547
West Indies:			French Africa	410,097	450,690
British	*10,137,055*	*13,454,557*	German Africa	6,313	29,526
Cuba	21,769,572	62,341,942	*Liberia*	*29,086*	*2,747*
Danish	633,710	734,020	Madagascar	19,278	10,450
Dutch	977,559	406,249	Portuguese Africa	2,324,216	
French	1,611,002	19,538	Spanish Africa	2,266	20,404
Haiti	2,383,424	1,107,734	Egypt	720,375	10,661,978
Santo Domingo	1,390,967	2,833,676	Tripoli		133,524
			All other Africa	*207,408*	*175,261*
			Total	1,420,137,619	1,025,719,287

SUMMARY.

	Exports.		Imports.		Total.	
	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
Metric	$614,000,000	43	$616,000,000	60	$1,230,000,000	50.3
Other	*806,000,000*	*57*	*409,000,000*	*40*	*1,215,000,000*	*49.7*

The result may be expressed in tabular form as follows:

[Expressed in millions of dollars.]

	Year ended June 30—								
	1903.			1904.			1905.		
	Exports.	Imports.	Total.	Exports.	Im. ports.	Total.	Exports.	Imports.	Total.
Metric	614	616	1,230	649	614	1,263	653	703	1,356
Other	806	409	1,215	812	377	1,189	865	415	1,280
Total	1,420	1,025	2,445	1,461	991	2,452	1,518	1,118	2,636

[Expressed in percentages.]

Metric	43	60	50.3	44	62	51.5	43	63	51.4
Other	57	40	49.7	56	38	48.5	57	37	48.6
Total	100	100	100.0	100	100	100.0	100	100	100.0

If we take the imports by themselves as being a great deal more important in this connection on account of customs duties being levied upon them, it is noticeable that about five-eighths come from the metric countries and three-eighths from the nonmetric. An analysis of the figures in some other respects might strengthen my argument, but it is enough now to insist upon the broad fact of a preponderance on the metric side, and particularly to call attention to its being comparatively recently that this has been the fact. Of course when the American colonies first separated from Great Britain, they were substantially of British origin, in spite of some Dutch, Swedish, and other settlers, and the greater part of the foreign trade of the United States was for many years with Great Britain and her possessions; but now, with the development of our trade with Germany, South America, and other countries, a smaller proportion of our total trade is with the British Empire, and of the other countries a greater number now than formerly use the metric system, as it had been gradually extending over the world.

In connection with this subject it is encouraging to learn that very active efforts are being made in England to secure the corresponding change in that country. To put the thing very briefly, the House of Lords, as conservative a body as can be easily found, actually passed in the Parliament which has recently expired a metric bill, which was not reached, however, in the House of Commons. The new Parliament, which has just now assembled in England, is said to be more favorable toward the metric propaganda than the preceding Parliament, and efforts will doubtless be made, and I trust successfully, to secure the passage of a bill in this Parliament. If this should prove to be the case there will be a still stronger reason than there would otherwise be for the use of the metric measure exclusively in the United States customs service. I would as lief have the United States lead England as be dragged after her.

Another consideration which seems to me to have very great importance in connection with this proposed change in the custom-house, is that of comity toward the American nations south of us, as to which I will briefly outline the action of the so-called "Pan-

American Conference." The act of Congress under which that was called was passed in 1888. Bills in regard to it were introduced by the Hon. James B. McCreary, of Kentucky, a Democrat, and Hon. William P. Frye, on behalf probably of James G. Blaine, a Republican; and both political parties with some justice claimed credit for it. The bill as finally passed was signed by President Cleveland, a Democrat, but he refrained from appointing the representatives on behalf of the United States under it, leaving the appointments to be made by his Republican successor. President Harrison made his appointments from both political parties, and it was recognized that it was a business of national importance and not a partisan affair. The members of the conference from other countries were entertained by the United States, having a special train which took them to various parts of the country; and during the time of their presence here this conference was perhaps the best-advertised proceeding in existence. The conference took up a variety of subjects, and with regard to most of them there arose difficulties or differences of opinion such that there was delay about many of them; but the subject of weights and measures, which was one of those specifically placed upon the programme by the act of Congress, was one in which there was entire harmony. Upon the committee to which this subject was especially referred the United States had a representative. The unanimous report of that committee recommending the metric system was adopted by the conference without any dispute, and Mr. Blaine, as honorary president of the conference, transmitted the report with the recommendation that a bill be passed by the United States Congress for the use of the metric system in its custom-houses in conformity therewith. Please notice that these gentlemen from the other American Republics did not come here on their own motion and force this matter upon the attention of the United States; it was by the invitation of our Government that they came, and it was by the act of the United States Congress that the subject of weights and measures was designated for their consideration; yet this recommendation upon which there was such harmony has been ignored in the subsequent legislation of the United States.

There was another similar conference of the American Republics a few years ago, as you probably remember, at the City of Mexico, and I think, though I have not lately looked up all the details, that as the sequel to that conference at Mexico there was a special meeting in the city of New York in regard to customs service in 1903, at which the recommendation of the use of metric weights and measures was renewed.

The third of these conferences is about to be held in the city of Rio Janeiro, and it is stated in our newspapers that President James, of the University of Illinois, is to be one of the delegates from the United States. It is also stated that an appropriation by Congress of $100,000 is desired to promote the success of the conference. It has also been stated that Mr. Secretary Root, although not to be a delegate to the conference, is to go himself to Rio Janeiro, with a view to having the United States make a favorable impression. It seems a very remarkable thing for the Secretary of State to absent himself from the United States, so that this is another indication of the importance of the business. Mr. Secretary Root, by the admis-

sion of both his friends and his opponents, is a very able lawyer, but how do you imagine that he can make our southern neighbors believe that the United States cares for their ideas in the face of such facts as above mentioned?

Mr. Charles W. Stone, who was a Republican, as chairman of the Coinage, Weights, and Measures Committee, 1896–1898, incorporated in his report in regard to the metric system a very strong statement with regard to this point of the recommendation of the International American Conference; to the paragraph he affixed the subtitle "National honor."

I have been satisfied that the battle for the metric reform was won ever since George M. Bond, whom I regard as wearing the mantle of Dr. Coleman Sellers, threw down his gun and abandoned the last trench of the defense of the customary weights and measures by writing to London Engineering the letter of which I inclose a copy. Whether he did or did not intend by his words to indorse more than a form of thread, I think you will agree with me on reading his words that they intelligently express indorsement also of the international system of screw threads.

Faithfully, yours, FRED BROOKS.

[Coppy of a letter published in London Engineering, vol. 61, p. 325, March 6, 1896.]

HARTFORD, CONN., *February 14, 1896.*

To the Editor of Engineering.

SIR: The writer takes considerable interest in the able editorial which appears in your issue of Engineering of January 17 on "The metric system and standard screw threads," and noted, at the time, your article appearing in issue of April 26, 1895, fully describing the French standard for screw threads, as proposed by the Société d'Encouragement pour l'Industrie Nationale, and adopted by the French Admiralty, and is especially gratified to find such hearty approval expressed in favor of the Sellers form of thread as is evinced by both the articles referred to.

In the adoption of the Sellers form of thread, with its included angle of 60°, flat top and bottom of the thread one-eighth of the pitch, making its depth 0.65 of the pitch, the French Admiralty has shown its keen appreciation of the simplicity of origination and ease of duplication which this form of thread embodies, and by not adopting the angle of 53° 8′ as recommended by the commission of the Verein Deutscher Ingenieure, proposed by Delisle, and over which much discussion was held; finally voted upon and recommended without the favor of many of the best engineers of Germany. Hence it is not at all strange that the form which lends itself to every consideration of economy should be adopted and made standard by the minister of marine for all naval construction authorized by the Government of France.

It is simply a case of the "survival of the fittest," and as such commends itself to all concerned in the endeavor to establish an international standard for screw threads.

There appear good and sufficient reasons for such a system, and as the series of pitches adopted by the French Admiralty is certainly a wise one, and as the metric system has been adopted by many governments, excepting, as is well known, those of England and the United States as a compulsory matter, and as Germany has for years labored under the disadvantages of the use of the Whitworth screw thread combined with metric dimensions, otherwise it would seem that it would be the easiest solution of the problem imaginable to accept the form of thread which has proved itself in every way peculiarly well adapted for practical and economical interchangeability, and thus be among the first to bring about the establishment of a screw thread which will be international.

At the risk of making this communication tedious in its length, the writer can not close without expressing his appreciation of the change of opinion of Engineering in regard to the practicability of the use of the Sellers form of thread for screws, as this favorable opinion was far from being so pronounced in an article which appeared in its issue of September 10, 1886, and which led to much of the discussion of the screw-thread question by the German engineers at the time. And as our experience in furnishing means whereby practical, economical, and convenient standard interchangeability in screw threads in this country has been secured, has been wholly based upon the adoption of the Sellers thread, and as that thread has been found to be in every way successful, we have reason to be heartily in sympathy with any movement which looks to that form of thread for its basis.

Yours, very truly,

GEO. M. BOND,
Manager, Standards and Gauge Department, Pratt & Whitney Company.

[The Kinsman Block System Company, No. 91 Liberty street, New York.]

NEW YORK, *April 23, 1906.*

Hon. CHARLES N. FOWLER,
House of Representatives.

DEAR SIR: I write you to beg to add my name to the list of those who are anxious to have the "metric system," Littauer bill, passed at this session of Congress. It is more than ordinarily desirable that such a bill be passed as an aid to engineers generally. Too much emphasis can not be placed on this matter by men engaged in technical pursuits.

Respectfully, yours, F. E. KINSMAN.

[John Hinrichs, cable-code publisher.]

BALTIMORE, *April 17, 1906.*

Hon. J. H. SOUTHARD,
Chairman Committee on Coinage, etc.,
House of Representatives.

DEAR SIR: I desire to add my testimony and opinion in favor of the introduction of the metric system of weights and measurements. I used to be in the export business of grain, seed, flour, etc., and the import of rice, beans, prunes, etc.; have clerked in Germany and France from 1873 to 1879, and am fully conversant with the disadvantages of the British system and the great advantages offered by the metrical system. I am now engaged in publishing cable codes, and thereby get an insight into various branches of the trade, and I confidently believe that the introduction would work few hardships, and that the benefits to be gained would be overwhelming.

From the standpoint of the export trade, there can be no doubt that we are at a disadvantage, as compared with France, Germany, Belgium, Netherlands, Italy, Spain, etc., especially in our trade with South American countries, which should be our natural field. The companionship of Great Britain in the old system is of no advantage to us. They have not shown the same advance in business as the metrical nations, and if adopted by the United States, England would undoubtedly follow.

Many manufacturers now calculate their articles on the metrical basis, while selling on the old-fashioned system. In some instances the change would necessitate new models, but the advantage to be gained and the fixed permanence of the new measurements would pay a thousandfold.

From the code-makers' standpoint I am also heartily in favor of the change. The advantage of knowing exactly all over the world what measurement a code word indicates (without any calculation or reduction of weights and measurements) would be great, and the consequent saving of a large number of code words, which have to be carried along in all codes at present, would be of great benefit. We have to allow for the metrical system in all codes at present, and the old British system is just so much dead weight, which could be abandoned in five or ten years, when the new system would be fully adopted.

In my opinion there should be no halfway measures. There should be a frank acceptance of the metrical system—kilos, meter, hectare, liter, etc.—and it would be best to adopt the foreign names. The 1,000 kilos would take the place of the ton—pounds, ounces, feet, inches, yard, fathom, furlong, gallons, miles, etc., would disappear. I would even be in favor of adopting the franc, though that is a question different from weights and measurements.

The period of transition should not last over four or five years. I would be overjoyed if on January 1, 1910, the new system were universally adopted.

Yours, very respectfully, JOHN HINRICHS.

[The Denmead Malting Co.]

BALTIMORE, *April 17, 1906.*

Hon. T. H. SOUTHARD,
Chairman, Committee on Coinage, etc.,
House of Representatives, Washington, D. C.

DEAR SIR: I consider the metric system of such vast advantage in our commercial and professional life that I beg to ask you to make every effort to prevail upon our Government to adopt it. Without going into details—the matter having been laid before your committee by people of culture and experience—I beg leave to say that upon the closest investigation this system has been put into operation by the most enlightened European governments to the greatest satisfaction of the people. It has been in abeyance here for a number of years, and with the change once made, the advantages will be so clear that the only surprise will be why it was not adopted by our Government long ago. There is no doubt that our people will adapt themselves quickly to the system, and that the change will prove to be of great benefit to our country.

Yours, very respectfully,

HENRY G. REMMERS, *Secretary.*

[The Wall Street Journal, 44 Broad street, New York.]

NEW YORK, *April 18, 1906.*

To the House Committee on Weights and Measures, the House of Representatives, Washington, D. C.

DEAR SIRS: I take the liberty of urging upon you the desirability of providing for the legal recognition of the metric system of measures, which authorizes the United States Government to make use of this system in its administrative capacity. It seems to me that sooner or later the metric system is bound to be extended, and, recognizing it as inevitable, the better process would be the most gradual method of introducing it with the least inconvenience to anybody. You have probably heard all the arguments necessary. Should you take this step it would go a great way toward unifying the measurements of the world and giving it in single units where we have many different ones now.

Hoping for favorable action at this session on your part, I am,

Very sincerely, yours,

JOHN FRANKLIN CROWELL.

NEW YORK, *September 9, 1906.*

Hon. JAMES H. SOUTHARD,
Washington, D. C.

DEAR SIR: I hope the Littauer bill will become a law in its present shape; it needs no improvement at this time.

The words, "except in completing the survey of land," which occur in the bill introduced in the Senate by Senator Beveridge, are very objectionable, because they infer that the metric measure is unfit for the purpose. The survey of the public land does not need to be done with scientific accuracy; the instructions to surveyors, unless they have been changed within the last forty years, allow them to disregard errors or apparent errors of as much as 0.72 per cent in the measure of certain lines. The surveys are, in fact, usually made with a chain of 10.0584 meters' length, though recorded as made with a chain of 20.1168 meters, having 100 links, each a trifle over 20 centimeters. The difference between 20.1168 and 20 meters being but 0.584 per cent is proof enough that measuring by meters is close enough for practical purposes. The survey to complete subdivision of lands between any two correction parallels may very well be done in sections of 1,610 by 1,610 meters, as the difference between 1,610 meters and 1 mile is only 0.65 meter, or 0.04 per cent.

When it becomes prudent to introduce a bill for metric measuring of the public land, the bill might provide substantially as follows:

Wherever in the survey of the public lands, the land lying between any two correction parallels is only in part subdivided, the subdivision of the remainder shall be done to conform with that of the other, and may be made either in 66-foot chains or by chain of 10 meters. But the survey of all other lands shall be made metrically and shall be recorded in meters and tenths of a meter, and each section shall contain as nearly as may be 256 hectares. The surveyors-general shall put this into effect as soon as practicable.

Provision like that might require remeasurement, not resurvey, of part of some standard meridians and correction parallels; but the benefit would far exceed the cost.

There is another thing I wish to suggest, but not for action at the present session: I have read somewhere that it is extremely doubtful that compulsory adoption of the metric system would be constitutional. I am of opinion that compulsory adoption might be brought about in this way: Let a bill be brought in "to fix the standard of weights and measures" and let it enact: That on and after the 1st day of July, 1908, the standard yard shall measure 1 meter in length and the standard foot one-third thereof. The standard pound shall weigh 500 grams and the standard ounce shall weigh 30 grams. The standard quart shall be 1 liter in capacity and the standard bushel shall have the capacity of one-third of a hectoliter.

An act of Congress having such provisions would be sure to be effective. Every buyer would demand full measure and every dealer would lose business who failed to give it. The engineer would no longer have a good foot to stand on. An inch would be 25 millimeters, with more than 12 of them in a foot; and there would be 40 inches to the yard.

Yours, truly, JAMES M. MCKINLAY.

[Clark University Library, Worcester, Mass.]

APRIL 13, 1906.

Hon. J. H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures.

DEAR SIR: I suppose you are bored to death with letters for and against the adoption of the metric system of weights and measures, and perhaps I am merely adding to the labors of an overburdened man in writing on the subject. However, I have been a textile worker for many years, have lived in England and in Russia, and am so fully persuaded of the merits of the metric system that, even at the risk of being considered a bore, I wish to express the hope that your committee may see its way to make a favorable report on the bill.

It is my experience, having tested both in business relations pretty thoroughly in my younger days, that the metric system is far superior to the system we now use.

With apologies for adding to your labors, I am, with high esteem,

Very truly, yours,

LOUIS N. WILSON.

NEW YORK, *April 9, 1906.*

Hon. J. H. SOUTHARD,
Chairman of the Committee on Coinage, Weights, and Measures, House of Representatives.

DEAR SIR: We desire to express to you our strong approval of the agitation in favor of the adoption of the metric system.

We have had it in use in our business for about eight years with entire success and satisfaction. It is convenient and exact, and has many advantages over the old cumbersome and unsatisfactory method.

It would naturally be of great advantage if the system were generally adopted.

Yours, truly, THEODORE A. KOHN & SON.

APRIL 3, 1906.

Hon. JAMES H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures,
House of Representatives, Washington, D. C.

DEAR SIR: Your favor of April 2, inviting me to appear before your committee at the hearing on the Littams bill, proposing the use of the metric system in the Departments of the General Government, was received to-day, and I regret extremely that I can not be present. This bill is one which I have favored and I have a few ideas as to why the metric system should be adopted, but it would take some time for me to prepare for putting these views in proper shape for your committee and the time is too short for me to arrange this and my business affairs, so that I can not give the matter the attention which so important a measure should receive.

It is a well-established fact, scientifically, that the decimal system of weights and measures is more scientific and correct than the present system. When our Government established a system of currency it was apparent that the decimal system was more convenient than the English system and it is impossible to calculate the economy which has resulted by their wise action at that time.

Our commerce with foreign nations in manufacturing articles which require standard sizes is rapidly increasing and in nearly all the countries to which we export goods the metric system is used.

I have in charge at present a construction in Cuba where the metric system is used and in certain cases goods are ordered from Europe because they fit the metric system, where we would have the precedence if our goods were made according to that standard. If the Government uses the metric system it will be easy for the manufacturers and the people at large to become accustomed with this most rational of all measures yet invented by the human mind.

I am heartily in favor of the measure, as are all scientific and artistic bodies of which I am a member, which includes the American Institute of Architects, the New York Chapter of the American Institute of Architects, the Society of Beaux-Arts Architects, and the Society of Columbia University Architects.

Yours, very truly, WM. A. BORING, *Architect.*

[Design department, Lowell Textile School.]

LOWELL, MASS., *April 13, 1906.*

Mr. JAMES H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures.

DEAR SIR: In response to your request I must say that my ideas in regard to the metric system of calculation so far as textile fibers and fabrics are concerned are very pronounced.

I have for the last ten years been engaged at the Lowell Textile School as chief of the cloth construction and design department. Previous to this I was engaged by some of the most successful manufacturers in England, Canada, and the United States.

My experience is not of a few days or months, but one of forty years' practical experience in the workshop, factory, and technical school as superintendent, designer, and instructor.

During the last ten years I have made thousands of analyses of different fabrics, including woolen, worsted, cotton, linen, silk, and many other fabrics composed of mixed yarns of every description. My experience has been thoroughly practical, and I have had to make calculations for each and all of these fabrics. You will understand that my life has been spent entirely in the textile trades.

In figuring out a fabric by the metric system, purely, I can save myself 75 per cent of the time.

As an illustration as to the value of time, I made a special test in an examination on cloth construction with one of my advanced classes at the Lowell Textile School. The cloth was figured on both the English and metric systems. By the English system there was not one student who finished under one and one-half hours, some taking over two hours. I changed the data to the metric system and the result was that every student had finished in forty-five minutes, several in less time.

I must say that my experience has been solely with yarns and fabrics.

I am personally in sympathy with the Littauer bill and hope to hear of it being favorably reported upon.

Yours, truly,

FENWICK UMPLEBY,
Chief of Department, Cloth Construction and Design.

[New York State Normal College.]

ALBANY, *April 17, 1906.*

Hon. JAMES H. SOUTHARD,
Chairman, etc., Washington, D. C.

MY DEAR SIR: Since I was unable to appear personally before the "Coinage Committee" at its recent sitting, I herewith inclose a few extracts from a longer article, which I recently prepared, and shall much appreciate your courtesy if you will cause the same to be printed in the record of the "hearings" before your committee.

Most respectfully, yours,

ALBERT N. HUSTED.

DIFFICULTIES ATTENDING CHANGES.

Of the "practical" difficulties attending changes of this character the history of our own country affords an instructive example. It will, we believe, be readily admitted that a people's currency may be more quickly and easily changed than its weights and measures. All that the Government need is to demonetize the old currency and issue the new in exchange. Theory says that five years would be ample for the substitution, but what says history? Our "Federal currency" was adopted by Congress in 1786, and all other currencies were declared "illegal" in the United States. We should notice that here, again, conditions were highly favorable to discarding the old and accepting the new. The long "war of the Revolution" had embittered feeling toward the "Mother Country;" the new currency was a daily witness to secured independence. But sixty years after pounds, shillings, and pence had been outlawed David P. Page, then principal of the New York State Normal School, at Albany, wrote as follows in his Theory and Practice of Teaching: "It is very much to be regretted that people of different sections of our country still adhere to the use of the old

colonial currency of pounds, shillings, and pence. It is universally admitted that the decimal system of the United States is the most convenient system in the world, and yet our people, after having adopted and legalized it and declared everything else illegal in accounts, still treat the system as if it were the worst of all." He urges the teachers of the country to use their influence in favor of the "new system." Twenty-five years after the above was written many of our merchants were still marking their goods in shillings and pence; to-day, even, the shilling as a unit of value has not entirely disappeared.

CENTURY SCARCELY SUFFICED.

If a full century scarcely sufficed to make this comparatively easy transition under most favorable conditions, who can number the years that would elapse in making the complete change of our entire "system of weights and measures" under existing conditions?

The fact that France, Germany, Switzerland, Spain, Norway, Sweden, and various other nations, large and small, have adopted the metric system, is often urged as a reason why we should do so. We should remember that the principal reason why the system was adopted in most of these countries does not exist in our own. "In the German Empire, previous to the change, nearly every little State had its weights and measures, differing from those of its neighbors, but of the same name." The same was true of Austria, Brazil, and South America generally. Even little Switzerland had about as many systems—if such they may be called—as she had cantons. Railroads and the increased exchange of commodities made such a condition of things no longer endurable, and the change was imperative.

SITUATION IN THIS COUNTRY.

Compare the situation as it formerly existed in the countries named with that in the United States at the present time. Here, from the Atlantic to the Pacific—3,000 miles—and from the Lakes to the Gulf—scarcely less than half that distance—we have the same Gunter's chain, with its decimal divisions, for all our land surveying; the same Winchester bushel for all our grain; the same inch, foot, and yard; the same pound and the same gallon. So far as home wants and domestic commerce are concerned, our system seems well adapted to our needs.

Theoretically and scientifically the metric system is doubtless superior to our own, but the practical difficulties in the way of its adoption by the people of the United States have, we believe, received too little attention. What would the farmer be likely to say when offered so much a hectoliter for his grain and so much a kilogram for his pork or butter. Possibly he would express himself in words more forcible than polite. Pursuing his investigations a little further, he soon discovers that he must buy new steelyards and new measures; that his great platform scale is no longer of any use to him, for the ton (millier or tonneau, he should call it), the foreign French ton which Congress has imported and passed a law compelling him to use, is only 0.9072 of the ton he has known all his life. When he offers his farm at $25 per acre he is told that land can not now be legally sold by the acre; the new law, for which his Congressman voted, says that land must now be sold by the hectare, which is 2.471 acres, or by the are, which is equal to 119.6 square yards, or, if you prefer, by the centare, which is 1,550 square inches. How many hectares he has to sell, how much he should ask for each, and how he shall get his deed translated into French are puzzling problems which test his patience and deplete his pocketbook.

IN CONCLUSION.

A few words in conclusion. Is it not plain, in view of what has been said, that history, experience, and common sense all unite in saying to our people: Sign no petitions favoring the complete introduction of the metric system; it would prove less convenient for you than the one which you are now using; the change would involve endless trouble, litigation, and expense; the practical difficulties are greater than you can estimate? To our Congressmen they say: Do not vote for so radical a change; ninety-nine hundredths of your constituents do not at all need this French system and will not use it; those who do need it have now full liberty to apply it whenever they can do so advantageously.

But to the scientists we will say: You need the metric system and you have it. Make it as useful as you can in your several departments, but beware of attempting to force it upon the people at large, for they do not need it and will not have it.

ALBERT N. HUSTED.

WILLIAM SELLERS & CO. (INCORPORATED),
Philadelphia, April 16, 1906.

Hon. JAMES H. SOUTHARD,
Chairman House Committee on
Coinage, Weights, and Measures,
Washington, D. C.

DEAR SIR: As we were unable to be present at the recent hearings before your committee, we desire to file our protest against the Littauer bill, H. R. 8988.

Our objections to the measure are founded in general on the following considerations:

1. It is not demanded by the general public, by the manufacturing interests, upon whom its provisions would fall, nor are we aware that it is demanded by the heads of the Government Departments.

2. In other countries where similar legislation has been tried, the result has been the introduction of confusion rather than simplicity. The old measures have been retained by the people to a great extent, and this is unavoidable.

3. In legalizing the metric units, and in furnishing standards for comparison, our Government has done its whole duty in the premises. If the French system is the best it will in time supplant all others.

4. Our experience of over forty years' use of the French metric system in one of our departments has shown us no superiority, for shop purposes, of that system over the English, and we have not been encouraged to extend its use. Did it possess practical advantages such as claimed, it would be to our interest to use it throughout our works.

5. The relations between units of different denominations, which is the merit of the metric system from a scientific point of view, is of no practical value to the manufacturer.

6. The decimal division is not, on the whole, as convenient for mental calculations or the ordinary purposes of the shop and market as the binary. Where it is more convenient, it can be and is applied to English standards, as by surveyors and by machinists in making fine measurements such as are expressible only in fractions less than one sixty-fourth of an inch.

7. There has been a steady and persistent effort in the manufacturing community for the development and adoption of standards in all lines of product. More has been accomplished in this country than in any other in this direction. We have, for example, standards in bolts and nuts, in pipes and fittings, in hose couplings, and innumerable other lines, so that it is possible to buy parts from different makers with the assurance that they will fit together properly. This is of incalculable advantage to the buyer and to the manufacturer, and has been the result of years of persistent effort. These standards can not be abolished by any legislation whatever; the resulting chaos would be intolerable. The law proposed could only

result in change of name by which the existing dimensions would be expressed in metric equivalents, resulting in awkward fractions, or new standards would have to be made, which would mean unnecessary duplication.

It has been stated by yourself, among others, that the bill in question will not impose any hardship on the manufacturers of this country. Whether or not this view is sound will depend upon the construction which is put upon the provisions of the act by the Departments with which business is conducted.

We can illustrate our meaning best by a concrete example. Suppose the Naval Gun Shop should require to purchase a lathe for boring and turning what are now known as 12-inch guns, but which we presume would hereafter be designated as 305-millimeter guns. Such a lathe usually has a face plate of about 85 inches diameter, and is long enough to take a gun of, say, 50 feet. The specification issued by the Department might only specify these general dimensions in metric equivalents, thus, swing, 2,350 millimeters; length to turn, 15 meters 240 millimeters. If no other requirement were made the proposition would present absolutely no difficulty to the manufacturer, who would simply offer his regular pattern of lathe of general dimensions nearest to those specified; but this is not strictly "using the metric system," and the conscientious officer might add to his specification a clause reading as follows:

The metric system of measurements must be used throughout this machine. All dimensions must be in millimeters. All screw threads must have metric pitch, and all bolts must conform to the international system of screw threads on a metric basis and normal sizes of diameters, etc., adopted October 20, 1900.

Such a requirement would be fully warranted by the terms of the bill. What would be involved to the American manufacturer attempting to meet this specification? He would have to make new drawings of the machine, change all the dimensions to millimeters, avoiding as far as possible fractions of millimeters. He would have to arrange for a new series of bolt sizes varying by increments of 1, 2, 3, or 4 millimeters, instead of by one-sixteenth inch, one-eighth inch, and one-fourth inch. He would have to adopt a series of bar steel sizes varying in a similar manner in place of those now used, varying by fractions of an inch. He would have to provide means of making and using these special bolts as cheaply as the bolts of the United States standard. This would involve a new set of drills, reamers, screw gauges, diameter gauges, threading tools, screw mandrels, boring cutters, etc., as well as metric lead screws or their equivalents. In addition to these changes, the proportions of the gear wheels would have to be modified according to the "module" system of metric pitches, which does not appear to be so convenient as the conventional "per inch" system which is general in this country, and will require the manufacturer to procure a new equipment of milling cutters of the proper shapes and sizes.

We do not think that the foregoing illustration is overstated, and admitting its possibility, we do not see how we can escape the conclusion that the manufacturer desiring to do business with the Government might be put to considerable inconvenience and expense. It has been argued before your committee that the expense of the special drawings, tools, and fixtures could properly be charged to the pur-

chaser, but even if the Government were willing to pay the premium demanded, it certainly could not compensate the builder for the inconvenience of attempting to operate two standards in one shop. Nor does it seem right to tax the Government (the people) for changes from which no practical benefit could result in increased efficiency of the machine.

We do not doubt the good faith of most of the advocates of the Littauer bill, and we recognize they sincerely believe that the adoption of the metric system throughout the country would be a national benefit, but we are sure that they do not appreciate what it would mean to attempt such a change in our system of weights and measures.

Trusting that you will permit our protest to go on the record, we are,

Yours, respectfully,

WM. SELLERS & CO. (INCORPORATED),
C. SELLERS, Jr., *President.*

MAIN BELTING COMPANY,
Philadelphia, April 18, 1906.

Hon. JAMES H. SOUTHARD,
Chairman Committee on Coinage, Weights, and Measures,
House of Representatives, Washington, D. C.

DEAR SIR: Referring to Prof. Alexander Graham Bell's address on the metric system to your committee some time ago, I am impressed with his thoroughly honest recognition of the fact that the compulsory adoption of the Littauer bill by the United States Government would mean its adoption (equally compulsory) by the people of the United States.

I have hesitated to answer so distinguished a scientist, though appreciating how vulnerable is his argument. Discussion with men more competent than I to answer, accentuates this vulnerability and, feeling as strongly as I do, I beg to offer the following in rebuttal, which I earnestly hope you will consider sufficiently to the point to entitle it to be printed, even at this late hour, as a part of the metric system hearings. I beg that you will courteously do me this honor.

Doctor Bell says that—

> it certainly is not right that a coal company should be able to pay their miners by the ton of 2,240 pounds and then sell their coal by another ton of 2,000 pounds.

This matter has nothing to do with the metric system. If there is any injustice in the operators' having two kinds of tons it can be regulated by the States. Introducing another ton of 2,204 pounds would not help the difficulty. The use of the terms gross and net tons would continue in spite of the introduction of the metric system.

Doctor Bell says further that—

> some of our people employ a pound of 16 ounces, others a pound of 12 ounces, so that it is necessary in business transactions to have a definite understanding as to the kind of pound we employ, whether avoirdupois or troy weight.

There is not one chance in a million of such an understanding having to be mentioned in any contract. The pound of 12 ounces, the troy pound, has practically no existence in commerce. Gold and

silver are weighed in troy ounces (anyone who has anything to do with gold and silver understands that), but never in troy pounds.

Doctor Bell also states that—

> our apothecaries use an ounce of 8 drams, whereas there are 16 drams in the ounce avoirdupois.

The ounce of 8 drams does not exist outside of the books. No one uses it in commerce. The apothecaries do not use it.

Answering Doctor Bell's further statement that—

> the avoirdupois pound consists of 16 ounces of 16 drams each, while the pound used by our apothecaries consists of 12 ounces of 8 drams each, equal to 96 drams.

The apothecaries use no such pound. There is what is called apothecary's weight in the arithmetics, but the apothecaries never use it except for prescriptions, and prescriptions never use pounds. The only pound used by the apothecaries is the avoirdupois pound.

Even if the chaos exists which Doctor Bell describes, it can easily be remedied without the adoption of the metric system, simply by legalizing one kind of pound only, the avoirdupois pound; and any advantage which the metric system may have in its decimal notation may be given to the English system by having the pound divided decimally.

Doctor Bell gives an example of the trouble of calculating in the English system:

> Take 1,906 inches; how many feet and yards? We must divide 1,906 by 12 to find feet and divide that by 3 to find yards. Or, take 1,906 ounces; how many pounds?

Such examples may be found in the arithmetics, but they are exceedingly rare in actual practice. We never measure such a quantity as 1,906 inches, and we never weigh such a quantity as 1,906 ounces. If the thing measured is cloth we measure it in yards and so many inches over, if there is a fraction—never so many feet. If the thing measured is a building we measure it in feet—never in yards or inches.

One of Doctor Bell's arguments is a very common one of the metric advocates, that it is very troublesome to calculate the number of gallons of water in a tank that is measured in feet and inches. This may be a good argument against the continuance of the gallon in the English system. It can easily be dispensed with and cubic feet used instead if the people wish to dispense with it, but there is no urgent demand that the gallon be disused. The people who do business in gallons very rarely, if ever, have to calculate the dimensions of rectangular tanks, and the only people who ever have to calculate the number of gallons in a rectangular or other shaped reservoir are the engineers, who are not making any complaint about the trouble. It is only the metric advocates who are making all the fuss.

Doctor Bell makes another calculation about the weight of a piece of steel. He finds the cubical contents of the piece of steel by multiplying together the length, breadth, and thickness so as to express it in centimeters. Then he multiplies it by the specific gravity of steel, which he says is somewhere about 8 (in fact it is 7.854 for soft steel), and he instances this to show the ease of calculating in the metric system. He makes the weight of the piece 10 centimeters long, 1 centimeter wide, and 1 millimeter thick, about 8 grams. It is difficult

to see how much easier this is than the English method. It can be measured in inches and decimals of an inch and the cubic contents would be multiplied by the tabluar figure for weight of steel per cubic inch, 0.2834, which is just as easily found in the tables as the specific gravity, 7.854.

Doctor Bell says the trade and commerce of the United States would be enormously facilitated by our using the weights and measures employed by the people with whom we deal. It has been testified before the committee by an appraiser of the custom-house that 75 per cent of our imports are in the metric system. This I have reason seriously to question, but, even admitting it for the sake of argument, the use of the metric system does not seem to be any hindrance on the import trade, and if our nonuse of the metric system is any hindrance to the export trade it would have been discovered long ago by our manufacturers who are increasing their exports by leaps and bounds without having adopted the metric system.

Doctor Bell describes the bill before the committee as being only mandatory concerning the method of arithmetic to be used (the metric system) and leaves the question of tools, etc., open. He says that—

> the bill simply prescribes that in the transactions of business requiring the use of weight and measurement the department of the Government shall use the weights and measures of the metric system. Under this language I take it that you can use anything under the sun if you measure it by the metric system. You can use a pound weight if you put it down at 454 grams.

I suppose Doctor Bell would admit also that a pound weight might be put down at 0.454 kilograms. What advantage would there be to the people of the United States, or to the Government, or to any department thereof to weigh things with pound weights and record them in the record as multiples of 454 grams, or of 0.454 kilograms? If the pound weights are to be used, they are going to be called pounds by everyone that uses them, and it is only the man who makes the official record who will be careful to put down pounds as 454 grams in order to comply with this proposed law. This alone suffices to show the absurdity of it.

Doctor Bell says:

> I understand that the metric system is already permissible in the United States by law. It is now competent for anyone to use it legally who chooses. This bill takes the next step and makes its use mandatory upon the Government Departments, and of course if you take that step it means that you are going further with legislation in the future and make it mandatory for the whole country.

Of course you are going further; otherwise what would be the use of the bill? Of course this bill is intended for an entering wedge, to be followed up by other legislation, but in order to diminish the opposition to this proposed bill, its proposers and adherents other than Doctor Bell, disclaim that there is anything mandatory about the bill except as to the system of arithmetic to be used in the Government Departments. If it is not intended at some time in the future to make the metric system mandatory upon the people of the United States, then what is the use of all the agitation and legislation about it? If people are to be allowed to use the old pounds in the actual operation of measuring, how is it possible to get rid of the English system?

Shall the Government attempt to compel the people to throw away their instruments of weighing and measuring and no longer use the names of these weights and measures in their language? Nothing less than this will be necessary if the English system is to be wiped out and the French system substituted for it. But can this be done constitutionally? I refer to the opinion of Attorney-General P. C. Knox in 1902 concerning two bills to establish the metric system as the legal standard of weights and measures in the United States and to require all Government Departments to use only that system except in completing the surveying of the public lands:

> The terms, figures, and characters in common and almost universal use in our system of weights and measures are just as much parts of the English language as is any other portion of that language, and to forbid the people their use would require as clear an expression of the legislative will as it would to forbid the use of that language in other matters, even if that would be effective. It may well be doubted if it be within the competency of Congress to forbid to the people, for this or for any other legitimate purpose, the use of this or any other portion of the language in which our Constitution, our laws, and our literature are written, and in which we orally express our thoughts and feelings. I am of opinion that neither of the bills referred to, if enacted into law, would at all affect the legality or validity of any contract thereafter made because expressing its stipulations as to weight or measure in terms other than those of the metric system.

With high regard for you personally, believe me,

Yours, sincerely,

WM. T. PLUMMER,
Secretary, Main Belting Company.

NORDYKE & MARMON COMPANY (INCORPORATED),
Indianapolis, Ind., April 17, 1906.

DEAR SIR: Not being able to appear personally before the Coinage Committee and make a statement regarding the metric-system bill, we would appreciate it if you would print this letter in the record of the hearings.

Formerly, upon casual investigation of the subject, we were inclined to favor a metric-system bill, but upon looking into the matter more thoroughly we became convinced that the passage of a compulsory metric-system bill would work a great hardship and an unjustified burden on the manufacturers and other business interests of this country. There are many millions of dollars' worth of appliances in this country, such as tools, jigs, dies, templets, and other appurtenances essential to the manufacture of the products of the United States which are designed in accordance with the system of measures and weights in common use, most of which could not be adapted to produce a product conforming to the metric system. It would take many years and a fabulous sum of money to enable the manufacturers and business interests of this country to become equipped with tools, utensils, and appliances in conformity with the metric system, and if Government purchases were based on the metric system many concerns that are now able to compete for Government work would have to step aside, because it would be utterly impossible to equip their plants so as to manufacture a common product according to the

usual weights and measures, and another product, for Government use, according to the metric system. In this way the cost to the Government would be enormous by reason of eliminating or reducing competition in the furnishing of products used by the Government.

Before the metric system could become effective, it would be necessary for the people, as a whole, to become so educated in the system that they could think and reason with the metric system. As an illustration, which is not overdrawn: The bottle-fed baby in its cradle would have to call for its liter of milk, instead of its quota of about two pints, and the mother or nurse would have to have measures accordingly, and, back of that, the milkman would have to sell his milk with metric measures, and reason and think and calculate in the metric system. All of this would require the evolution of ages, and could not be brought about by any arbitrary law. Theoretically, the metric system is a good thing, and if our people had adopted it in the beginning, it would, at this time, be a desirable system, but having been educated and equipped, for generations, with our own system of weights and measures, in our judgment it would be a fatal mistake to attempt, at this time, to force on our people a system the adoption of which would be confiscatory in its enormous cost.

Yours, respectfully,

NORDYKE & MARMON COMPANY.

Hon. JAMES H. SOUTHARD,
Washington, D. C.

The COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
Washington, D. C.

GENTLEMEN: I appeared before you April 3 and 4 in my capacity as president of two manufacturing companies, and as representing unofficially the general feeling in the National Association of Manufacturers, the Manufacturers' Association of New York, the American Society of Mechanical Engineers, the National and the New York Metal Trades' Associations, and also the Naval Architects and Marine Engineers, with all of which I am connected as a member; but I appeared as a special representative of the Manufacturers' Association of New York, a body composed of about 700 members scattered through the State of New York, 350 of whom constitute the most prominent manufacturers of Brooklyn Borough, in the city of New York, the balance of whom have offices in the borough of Manhattan and shops in New York State and elsewhere. This organization has listened to the special advocates for and the opponents of the metric system, and after the hearings has repeatedly voted almost unanimously against the measure in every case, believing it special class legislation of a vicious character, advocated by very few having any knowledge of the practical effects of its attempted compulsory use, and of the confusion which would result, should anyone attempt to enforce its use upon others than themselves.

The enthusiasts favoring the introduction of this system all seem to forget that if there was any advantage in the proposed law, it is now a legal system and one which could be used under any circumstances, should it be considered advisable. In this country any con-

cern or body attempting its use would soon find that their business would suffer very materially, as business is too well organized and is in too satisfactory a condition at present to permit freak legislation like this being passed without resenting it in some effective way. It must be remembered that legislation which does not have back of it those most interested in its use always remains a dead letter even if such a law is passed. Legislation which is not backed favorably by public opinion always remains a dead letter even if passed. This class of legislation is to-day one of the most dangerous results of too many sessions of our State and National legislatures. Our law volumes are full of measures which have been passed through thoughtlessly, when introduced by some well-meaning though not fully informed member of our law-making bodies. The number of these ineffective and inoperative laws is one of the greatest sources of discontent and frequently of blackmail, and it would seem advisable from some points of view if some power could be given to our supreme courts to strike from our statute books at frequent intervals this common class of freak legislation.

I am sure that all parties who have any business relations with standards of permanent measurement would believe, could such a method of getting rid of such bills be in existence, that this bill, should it be permitted to be placed upon the statute books, would be crossed from it by the courts at the first opportunity; but now, unfortunately, such bad legislation, once put upon the statute books, even though it would immediately go into a condition of "innocuous desuetude," it would still be there, where some irresponsible party might invoke it for effect, as is now the case in several countries which have foolishly permitted the metric system to get a statute rating, though not of such practical use as legislation should be conducive to.

I do not believe that the devotees of the metric system, any more than the devotees of some of the eastern religions who start out on world-wide journeys to gather in the cash of the restless, believe their peculiar form of belief will have any permanent position in the affairs of this nation.

This system of measures, which was born at the same time as the French revolution and French atheism, should have been permitted to die with them, in so far as any attempt to force it upon the English and American nations is concerned. The system of the inch, foot, and mile is the result of the necessities of more business men and business conditions through more continuous time than any other system, and it is in use freely by more people than the metric system has had assigned to it by legislation, and but a part of those nominally classed as using it do so as a fact. If anyone doubts this, he has only to consult Messrs. Halsey & Dale's remarkable evidence. If any class of men have strong ideas on this subject, it is that class who are in constant touch daily, hourly, and almost every second with standard linear measurements, such men as build our railroads, our vessels and machinery, and every article which we use in our most common conveniences of life, and yet who are uncompromising opponents of this vicious scheme to force upon the American workman a system foreign to our thought and methods. Among those who have taken strong action against the system are the members of the American Society of Mechanical Engineers, who cast a comparatively small vote in its favor

among those who voted at all; and no one doubts that every member who desired the system voted in favor of it, while the heavy vote was cast against it; but the majority of the members of the organization considered the chances of the bill compelling its use being passed too small to vote at all. The president of this society, whom I have heard was very emphatic in the stating to you his opposition to the introduction of this system, although personally a very broad-minded engineer and one who started out with the influence of the theorists still swaying him, believed in the value of the system; but his opinions have so changed that in private conversation he becomes very emphatic in its condemnation.

Every organization, like the Railroad Master Car Builders and Railroad Master Mechanics, is unanimously against it, and their decision on any measure in convention is more powerful than any law for or against a standard, because the decision is reached only after experience has taught it to be right, and once passed by a vote it is almost as unchangeable as the historical laws of the Medes and Persians.

Another organization, the Naval Architects and Marine Engineers, many of whose members are in the naval service, and more of them have been, are almost unanimously against it as members and as a society, and it is the members of this body who would be most affected by it and who would have to work under it very generally. The bill would impose still heavier disadvantages on the service of the United States Government than now exist, and they are now great enough to drive from the service or to a nervous death many a man whom our Government can not spare at this time.

The great National Association of Manufacturers, whose membership consists of 3,000 firms of the highest standing, operate factories in all varieties of manufacture, and whose heaviest assets and machinery are made to a scale which is in parts of inches and feet, all of which will be affected by the subsequent bill which will be introduced, as it is already stated that this measure is to be the opening wedge. This organization, at much expense and great labor, obtained the opinion of its members and has registered it before you upon more than one occasion. Powerful organizations like the Machinery Manufacturers, the Machine Dealers and Supply Men, the Hardware Men's Association, the National Metal Trades' Association, and many others have registered their opposition and would resent the passage of such a bill as this. This bill goes further than any of the previous ones in that it brings in the title deeds to all Government lands. The Government could not give a deed any more intelligible than a Spanish grant when disposing of any of the millions of acres of surveyed land not yet settled, which have taken years to map out. What real estate owner wants to have the risk in a title of a computation by an average clerk in a register's office or in a lawyer's office, when he has to record a deed to a piece of property which has passed through Government hands?

When we call in the much-cursed plumber or gas fitter, who wants to have two men walk to and from a job at a low estimate in time and distance, say, of half a mile in an hour, to get a $\frac{1}{2}$-inch elbow which they thought was of one standard or the other, and when they attempt to do their work find it is to be a special elbow with one end fitted one side to the old standard and the other to a new one? For, mind you,

this is the only country which has a standard which has become recognized as such in pipe fitting, and it took many years of agitation and experience to get the adoption of that system.

What fair-minded business man can respect the opinion of prominent advocates of this measure when they say that it is of no consequence if it does cost one firm a million dollars, as it will extend over several years. Is this not unconstitutional legislation, taking property without due process of law? The direct loss to the mechanical industries in new drawings, tools, jigs, patterns, and records would undoubtedly cost over $500,000,000, and for what purpose? To satisfy the unsatisfied spite of an expatriated newspaper man. To meet the unsatisfied hope of a lot of theoretical instructors who never were connected with the affairs of life whose results were the advancement of the inhabitants of this country; for our recent great change for the better in life conditions is the result of the thorough adoption of our methods of standards, and this standard can not now be changed by the mechanical world, whatever may be thought by the advocates of this bill.

When this country backs a new commerce which carries our goods to other lands as does England, then will there be no confusion over this proposition. The inch, foot, and mile will soon be the only recognized system, even with its late start as a militant system, than the metric, which system has for a hundred years been backed by a fighting band of agitators who could see good in no other system.

Respectfully, yours,

FRANCIS H. STILLMAN.

STANDARD SCREW COMPANY,
Detroit, Mich., April 16, 1906.

Hon. J. H. SOUTHARD, *Washington, D. C.*

DEAR SIR: In concluding your consideration of the bill in regard to the adoption of the metric system by the departments of the General Government, I beg to again remind you that I am, and have been since 1882, engaged in a line of manufacture whose product is absolutely indispensable to every machine extant, from a watch to a war ship.

There are only about twenty-five companies engaged exclusively in this line of manufacture, and this fact brings my company (and our competitors) in close touch with all of the manufacturers of machinery in the United States. I have, within the last sixty days, conferred with those of our competitors who, together with my company, manufacture much more than half of the goods of our line made in the United States, and have learned that none of us have ever had any inducements to make goods by metric measurements. The manufacturers of American machinery are not a sleepy lot. They are wide-awake to every system which will further their interests. They know the metric system, and would not be slow to adopt it if it were good for them.

The adoption of the metric or any odd system by the departments of the General Government would, in my judgment, render them

liable to very serious embarrassment in an emergency. Let me cite an instance of actual occurrence:

During the Spanish-American war, the War Department had a contract with the Falls Rivet and Machine Company, of Cuyahoga Falls, Ohio, for shells. The demand was so urgent for shells that the Falls Rivet and Machine Company had to increase its capacity. To do this they had to depend upon my company and its competitors for parts of their machines. We were compelled to work night and day to supply these parts. Now, suppose such a bill had become a law, what would have occurred? There might have been some one company who, having a "pull," might have been fitted up for the metric work for the departments of the General Government, but they could not supply the needs of such an emergency, and others would have to make new tools, new measuring instruments, etc., and the delay would have been intolerable. No human power could avert delay and disaster incident to it.

Don't let the departments of the General Government use a different system of measurements from the common herd. It would be less dangerous if they were compelled to use a different language, because interpreters could be found who could make quick translations, but when it comes to designing new machines, that takes time. Then follows pattern making, tool making, etc., cutting them out from solid steel, bronze, iron, etc., and each operation takes time. It would leave the departments of the General Government in a state of unpreparedness in such emergencies as above cited as might result in the defeat of our arms.

Manufacturers of American machinery are an important factor in the body politic. Their interests are greatly diversified and very extensive, and their numbers are legion, but they are, every one, brought in touch with this little corterie of manufacturers of our specialty, and they are quick to adopt every good appliance of use to the skilled mechanic, and when they adopt it, we know it. When they want the metric system, we will want it. If there were any signs of it coming into use, we would be first to adopt it. It would cost this company more than $100,000 to change to that system, and we would have to carry both for a decade or two, and while the bill specifies that it is for use in the departments of the General Government, it is useless to try to disguise the fact that it is designed to make it general. And for that matter it is all the worse if it be not general, if the bill passes at all.

Yours, very truly,

GEORGE THRALL,
Secretary Standard Screw Company.

PHILADELPHIA, PA., *April 11, 1906.*

Hon. J. H. SOUTHARD, M. C.,
Committee on Coinage, Weights, and Measures,
House of Representatives, Washington, D. C.

DEAR SIR: I have been asked to write you with reference to the pending bill, H. R. 8988, for the compulsory use of the metric system by the departments of the Government, in order that you might have the views of one who, for a long time, was in charge of a bureau of

the Navy Department, whose business comprehended measurements at every turn.

My whole life, since the age of 16, has been spent in connection with manufacturing and engineering, so that I have had every opportunity to understand the bearing of systems of measurement on engineering and manufacturing practice. This is mentioned in order to emphasize the fact that I am not giving a mere opinion on something with which I have had nothing to do, as has been the case with so many eminent scientists who have appeared before your committee, and who, while justly honored for the splendid work they have done in their own lines, are, as a rule, entirely unfamiliar with the practice of the drawing room and work shop, and therefore express views which can only cause a smile from men with thorough mechanical training.

It seems to me that the bill, as drawn, is very unfair, because it pretends to apply only to the Government Departments, and yet, as a matter of fact, must inevitably apply to manufacturers throughout the country. It looks to me very much like an attempt to bring the metric system in by what is supposed to be the insertion of the thin end of the wedge. It seems to me it would have been fairer and more ingenuous if the bill had remained the same as it was when I apeared before your committee in 1902, at which time it was frankly stated that it was the intention to make it the legal system for this country.

I do not know that I can add any new arguments to convince you of the inadvisability of forcing the metric system on the country, but I wish to say very strongly that after very careful consideration of the subject I believe that it would be a decided mistake to make its adoption compulsory.

If you will pardon me for saying so, there are some aspects of this battle of the standards, as it may be called, which are very much like a theological controversy. Some eminent gentlemen, for reasons personal to themselves or their line of work, who find the metric system useful and more convenient than English measures, immediately become propagandists of the faith and want to compel everybody else to do as they do.

A great deal has been said about the importance of having a single standard and of the confusion which arises on account of different units with irregular ratios to each one. It seems to me that this claim is largely made by students and men of an academic rather than a practical turn of mind, who are so carried away by admiration of the beautiful theory of the metric system that they lose sight of the real object of systems of measurement.

A reasonable study of the question ought to satisfy any candid inquirer, it seems to me, that in general each line of work gets the units which it wants, just as we so often say that every country gets the kind of government it desires.

Some scientific men of the first rank have appeared before your committee and talked in a way that would lead one who did not know to imagine that manufacturers of machinery used all the units given in the ordinary table of long measure. Now, as a matter of fact, in the manufacture of machinery there is really only one unit, the inch. In calculations the inch, with its decimal multiple and submultiples, is used; in carrying out work where the binary division is more convenient, that is used. As we all know, in the business of

selling fabrics the yard is the unit, and anyone who has observed the subject at all will realize why women think in yards, while mechanics think in inches.

I have called attention to this point because I believe a lack of appreciation of this point is at the bottom of the trouble we are having. It makes no earthly difference to women, who never build machines or have anything to do with them, whether the unit used in the machine shops is the inch, the millimeter, the foot, or anything else. It would only be carrying the unreasonableness of the pending bill several degrees furthe rfor the women of the country to rise up and demand that the yard should become the unit of the machine shops because they found it so very convenient in measuring cloth.

I want to call attention also to a great mistake which is being made and which, with due deference, I find you made in a question asked me four years ago, namely, that the metric system is used by such a very large number of people. In making up the number of users of the metric system, countries are included where the vast bulk of the people have nothing whatever to do with measurement and where the manufacturing interests are also nil. For example, in a table which I have seen giving the total number of people using the metric system at over 400,000,000, such countries are included as Java with nearly 30,000,000, French Colonies with about 30,000,000, the Ottoman Empire with 39,000,000, Mexico with 11,000,000, Brazil with 14,000,000, and Japan with 40,000,000. Now, without going into the matter with great care, I think it must be evident to every fair-minded person that it is absurd to quote these countries, and even more so to include Russio, as has been done, in comparison with England and the United States, which are such great manufacturing countries. From my own personal observation I should say that it is extremely probable that in the whole of South America there are not as many people engaged in manufacturing as in our own little State of Rhode Island.

The Government has for years made it a policy to encourage our manufacturers, and even free traders are willing that a tariff for revenue should give them incidental encouragement. This scheme to force the metric system on the country would be a blow in the face at the manufacturers, which would cost them an immense amount of money, great confusion, and a serious loss of efficiency for a number of years. A former assistant of mine, who is now engaged with one of the great manufacturing companies of the country, tells me that he has given you an estimate that it would cost his company $1,000,000, to say nothing of the loss due to reduced efficiency and confusion.

Now, my position in the matter is, I believe, very much the same as that of most engineers of experience who have studied the question, namely, that we believe the metric system should be left to make its own way. We have no objection to its use by anybody who finds it more convenient in his particular line of work than the English system, but we do believe that it would be a radical mistake and would be very unfair to attempt to force its use by making it compulsory in the Government Departments, and thereby compelling a large number of manufacturers who do business with the Departments to adopt it.

Your attention has been called by a number of those who have been before the committee to the repeated instances where the manufacturers of the country have agreed to the adoption of standards where there had been diversity of practice with attendant confusion, even where this action involved them in considerable expense. There was, however, a corresponding benefit to offset the expense. I can not see that the compulsory adoption of the metric system would benefit the manufacturers of the country or the Government Departments in any way, while it would represent, both to the Government and to the individual manufacturers, a very large expense, a great amount of confusion during the transition period, and a loss of efficiency.

Believe me, with great respect, yours, very truly,

GEO. W. MELVILLE,
Rear-Admiral, U. S. Navy, late Engineer in Chief U. S. Navy.

To the Committee on Coinage, Weights, and Measures, United States House of Representatives.

Abstracting and supplementing certain remarks made by me before your honorable committee last year:

We are confronted with two alternative systems for our weights and measures, both of them admittedly imperfect. Thus numerous manufacturers who, like myself, disapprove of the adoption of the metric system should not, and mostly do not, attempt to apologize for the gross inconsistencies of the English system; and we do admit the theoretical beauty of the metric system for many of the calculations involved in using it.

Could we all start afresh in a new world, the metric system would probably be adopted as the best, in spite of its being founded upon the number 10 as a numerical basis. This number originated accidentally and has no intrinsic merit of its own. Any other number, which would be expressed by one and naught would be just as good for calculation and have all the advantages of the decimal system as such. The ideal number is 16, on account of fewer figures being required and because it is capable of binary division, which is an essential feature in all practical matters of commerce and the industrial arts. Some of us, therefore, feel that in view of this greater change happening some time, it is not worth while to make a smaller change now which will cause enormous trouble and expense to many of the manufacturing industries of the land, especially those connected with the mechanical constructing arts.

Without, therefore, saying whether the metric system might not be easily applied to our weights and our measures of capacity, as liquid measure, etc., we practical engineers and manufacturers mostly oppose abandoning our present measures of length, not because they are beautiful or perfect in themselves, but because such an enormous number of standards have been adopted, the dimensions of which are expressed in whole numbers or in simple fractions.

All of these, if they remain standards, must be expressed in millimeters, etc., with from one to four places of decimals with each whole number.

To give an instance of my own experience: In the Ferracute Machine Works, which I control, running less than 200 men, we make

about 1,000 different kinds and sizes of presses, besides many small articles. Each of these will average more than 100 pieces as component parts. As many of these as possible are made interchangeable among the different sizes; but there are probably some twenty or thirty thousand distinct pieces which are standardized, and each one, upon all its working drawings, must have a number of dimensions marked. Allowing an average of 10 dimensions, we should have somewhere near a quarter of a million figures upon our drawings to change. Various names and symbol numbers would also have to be changed upon the special tools pertaining to these particular pieces. These tools are mostly of iron and steel, many of them hardened so that new markings can not be stamped upon them, nor can the old marks be obliterated except by grinding them away. There are also numerous wooden patterns with names and symbols upon them. To such work of changing we would, in many cases, have to add the changing of duplicate drawings and of innumerable indexes and records of various kinds. Many of the drawings and tools mentioned will last a lifetime, with some changes and improvements, but they do not often need renewing entirely.

Many of the names and sizes mentioned have been committed to memory by ourselves and our workmen through a long course of years. All of these would have to be forgotten and learned again in a new and unfamiliar numerical language, and this is only for a comparatively small shop. There are, however, hundreds of thousands of shops throughout the country employing thousands of men and with a consequent much greater magnitude than the one mentioned. This work of changing figures, in the aggregate, would cost millions of dollars, to say nothing of the consequent confusion and retarding of business.

In addition to the machine shops, there are innumerable other industries which I can not here mention. Among them are all the building trades, with their standardized lumber, iron bars, etc. These are now known as 3 by 4 scantling, 8 by 12 beams, inch boards, etc. The confusion incident upon new names, with their long strings of decimals, is almost beyond imagination; and then there is the land business, with its millions of city lots, 20 or 30 or 50 feet wide by so many hundred deep, to say nothing of all the land described in terms of acres, square miles, etc. The amount of work and confusion in getting these redescribed in the new language, and the amount of profanity consequent upon such confusion, and the fact of having to talk in this language ever after is appalling. All the above is upon the assumption that the actual dimensions of the present standards could not be changed. Were they changed so as to read in round numbers as far as possible, in terms of metric measure, the work and confusion would be too great to here describe. Not only would all machinery and many other manufactured goods have to be redesigned, but the new parts would not be interchangeable with parts out already in use; and thus the enormous advantage of the American system of being able to furnish duplicate parts would be lost, so far as its application to things now in existence is concerned. The losses to business in general in these two ways would be counted by billions and billions of dollars, and the general retardation of business would be greater than we have ever dreamed of. Such chang-

ing of standards would be impracticable except through a term of many generations. The real result would be that we manufacturers would have to run two systems, gradually making some of our machines with metric measures while the bulk of our work would go on dimensioned in feet, inches, etc., in spite of all laws that might try to compel us to work otherwise.

Respectfully, yours, OBERLIN SMITH.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY,
Pittsburg, Pa., April 2, 1906.

Hon. J. H. SOUTHARD, M. C.,
Chairman Committee on Coinage, Weights, and Measures,
House of Representatives, Washington, D. C.

DEAR SIR: On behalf of the Westinghouse Electric and Manufacturing Company, and as voicing the wishes of its management, I desire to enter an earnest protest against the bill, H. R. 8988, for the compulsory use of the metric system by the Departments of the Government, and respectfully urge that your committee report the same unfavorably, for the following reasons:

(1) It is an insidious and disingenuous method of forcing the metric system upon the country generally.

The relations of the various branches of the Government to industry and maufacturing are so numerous and so close that, if these Departments must use the metric system, it will compel manufacturers either to shift over to the new method entirely, shift over in part, or cease to do business with the Government Departments.

Firms whose main output goes to the Government, like some of the shipbuilders, will be forced into the new system, for it is obviously impossible that they should use one system and the Government another.

Where Government work forms only a part of the output of a firm, it might set apart a portion of the works and equip for the new system, or it could cease to bid for contracts with the Government. The former means an unnecessary increase in expense. The latter is an alternative which is hardly consistent with the avowed desire of the Government to secure wide competition.

The foregoing is cited to show that manufacturers have a vital interest in the bill, even though its wording is evidently meant to convey the idea that only the Government Departments will be affected.

In brief, the Government is not a manufacturer (except for a very few things) and therefore must buy from those who do manufacture, so that the bill affects them just as directly as if they were explicitly included in its wording.

(2) The introduction of the metric system will produce no benefit whatever to my company and most other manufacturers, and will cause us actual loss in money and time, a reduction of efficiency for a considerable period, and great annoyance and confusion.

(3) The alleged superiority of the metric system for calculation is not a fact in our work. We use the inch with its decimal multiples and submultiples in calculation, so that the two systems are equal.

(4) Persons who do not know the details of the electric industry have stated that it is so tied up to the metric system that it would confer great advantage to adopt it. This is not true. Some units are natural constants, and the others can be defined just as easily and exactly in English as in metric units.

Our designers say that the use of the metric system would confer no advantages, and it would for a time cause delay while they were getting accustomed to it. All our records are in English units, and these would have to be recalculated into metric units, causing loss of time and considerable expense.

(5) The cost to us of making the change would be in the neighborhood of a million dollars. Four years ago I gave figures of over half a million. Our works have grown in the meanwhile, and the cost of the change would now be much greater.

This cost is made up of the substitution of new patterns, dies, jigs, templates, scales, and measuring devices in the shop, and of new drawings.

The necessity for these is because it would be impossible to use the existing ones for metric measure, on account of the incommensurable ratio between the meter and the inch.

When work is laid out, the dimensions are always such as come on exact divisions of the scale. As the metric and English scales do not coincide anywhere, the existing English measurements would not come to any division of the metric scale, thus involving inaccurate work and unsatisfactory machinery. If it be said, why not use verniers and micrometers, the answer is that this means increased time and cost.

(6) There would also be the increased expense of maintaining part of the works on the old system to supply repair parts.

The committee has been favored with opinions by those who were avowedly ignorant, because not in a position to know, to the effect that the opponents of the metric system have greatly exaggerated this feature.

Your earnest attention is called to a few facts, as follows:

There are now in use, and rendering good service, over 3,000 railway motors which we built from 1892 to 1895, and for which we daily get orders to supply repair parts.

The first of the great generators at Niagara Falls were supplied over ten years ago, and they will be used for many years yet.

There are thousands of motors and generators of various types which we built from five to ten years ago, which will be efficient for years to come, and for which we are constantly supplying repair parts.

This simply means that certain parts naturally wear out in use and when replaced make the machine as good as ever.

The "repair part" business of my company amounts to about a million dollars a year. This is not surprising when it is known that the total output to date is valued at about two hundred million dollars.

These are facts based on an inspection of our records. In view of such facts, the airy way in which ignorant persons attempt to dispose of the subject is really outrageous.

(7) The efficiency of all who use measurements in calculation, designing, drafting, and fabrication would be seriously impaired for a time.

It is easy to prove this yourselves by testing persons who claim some familiarity with the metric system but do not use it habitually. It will be found that they really think in the English system and translate to metric. When it comes to compound units, such as pressures or strengths as related to areas, it takes a long time to get any realizing sense of values in the new system.

(8) Study of the printed testimony before the committee shows that, with few exceptions, those who advocate the adoption of the metric system are men who have nothing whatever to do with making things, but only measuring them after they are made. There is an enormous difference between the two cases. Their measurements are made for purposes of calculation, and any decimally divided scale is convenient.

It must not be thought that the essence of the metric system is decimal division. Its essence is the constant ratio. It happens to be 10, but the real good features of the system would be the same if the ratio were 8 or 12. Many think they would be greater.

A distinguished chemist commented on my testimony four years ago that my statement about the incommensurable ratio of the units preventing the working to exact sizes was the weakest argument he had ever heard. That was only because he was ignorant of manufacturing. Anyone skilled in shop methods would tell you just what I did.

(9) Manufacturers do not object to anybody using the metric system who finds it more convenient. Perhaps chemists do. We do object most strongly, however, to having chemists, astronomers, and others, who know absolutely nothing of the details of manufacturing, try to dictate to us how to run our business. We believe also that, under the simplest rules of evidence, they should not be allowed to express opinions about our line of work. Their earned reputation in other lines has a tendency to give weight to their erroneous opinions unless contradicted.

The printed testimony shows that manufacturers, as a rule, have told what they know, while the scientists have been allowed to tell what they think, which, as affecting lines other than their own, has generally been entirely wrong.

(10) To abandon the inch for the millimeter means the giving up of many standards of the highest value, such as threads for bolts and nuts, and for pipes, with nothing to replace them. My testimony of four years ago goes into this at length.

(11) The claim is made that we now have a great confusion of units and ratios, all of which will be removed by adopting the metric system.

To this the answer can be made with absolute certainty that such will not be the case. We shall simply add the metric units to the others. This has been the history of France and Germany, in the former of which the metric system has been in use over a hundred years.

This talk about confusion really comes from a confusion of ideas and a lack of understanding of the object of varying units.

The fact is that each trade or business uses the unit which is most convenient to it.

Manufacturers of machinery have really only one unit—the inch. Everything else comes from it. Builders use the foot and inch. Others find the mile a convenient unit. Astronomers find for some purposes that a "light-year" is a useful unit. We have no objection.

There is no reason why the factories which make cloth should use the same unit as those which make machines.

(12) For about forty years it has been legal for any one who so desires to use the metric system. Why has it made so little progress if it has such advantages as its friends claim?

Manufacturers have shown again and again that they are ready to abandon old methods and adopt new ones, even at great expense, when there is some benefit in doing so. A vast number of the responsible men in our great factories are technically educated men who have used the metric system at college and have had a chance to test it. If it had any real advantage they could, through the great engineering societies, easily agree upon its adoption.

Please note that the Society of Mechanical Engineers, after an elaborate consideration and discussion of a report which gave both sides of the case in great detail, voted by letter ballot against the adoption of the metric system by a ratio of 3.6 to 1.

In conclusion, it is respectfully submitted that the arguments against the compulsory adoption of the metric system are so tsrong as to be convincing.

This bill is an attempt of pure scientists, to whom the matter is not vital, but at most a choice between two good systems, to force upon people to whom it is a vital matter a system which, after thorough investigation, they do not want and which would cause them annoyance, expense, and inefficiency in their business.

With great respect, yours, very truly,

W. M. McFARLAND,
Acting Vice-President.

WILCOX & GIBBS SEWING MACHINE CO.,
New York, April 10, 1906.

Hon. J. H. SOUTHARD,
Chairman Committee on Coinage,
House of Representatives, Washington, D. C.

DEAR SIR: Metric bill, H. R. 8988. Not having had the opportunity of appearing before your committee in person, I beg that you will include in your printed testimony this communication, which is a revision of my several letters to you opposing the metric bill.

It is claimed by the exponents of the bill that it applies only to the governmental departments and is not mandatory upon the general industrial and commercial public. This seems to beg the question, because if the metric system is not adapted for general uses it would seem not to be suited for Government purposes. However this may be, the fact remains that the bill is mandatory, and in one way or another, beginning at the customs door, through which pass annually an enormous volume of innumerable variety of imports and exports in connection with which calculations of weights, measures, and

values are universally necessary, such a law would permeate every branch of manufacture and commerce, and at once two standards would be set up requiring in all minutiæ of detail, calculations, and adjustments, and nearly always a double column of values and measurements; but beyond this initial confusion and consequent large expense and fluctuating book and market values, to arrive at a parity, there would follow widespread derangements of manufacturers' plans, tools, jigs, screws, etc., in order to meet the demand for any article required for Government use all over the country. Your letter of March 12 asks whether there would need to be any such change in factory operation for the manufacture of machines already on the market in case the metric bill should pass. In asking this question you miss the real issue, although you may not know it. Of course the same machines now on the market could be hereafter made with the same plans and tools as now, regardless of the Government requirement, but here is where the little joker comes in.

The proposed bill is so brief that one is apt to miss its immense scope and effect. Its language would compel "all Departments of the United States Government to use the metric system." What does this little phrase mean? Every inquiry, advertisement, order, and contract of the Government in which weights and measures are mentioned must thereafter be stated in metric terms, from a trifling order for stationery to a contract for a battle ship, in the latter case with its almost infinity of calculations. If a machine or mechanical device of any kind is needed, the specifications must be phrased to fit the metric system, and if the head of a department is unable to express himself in the new language of measures, so much the worse for him. The greatest burden, however, would fall upon the manufacturer. For instance, take "Schedule 182, Bureau of Equipment, Navy Department," or "Proposals for underwear for Navy Department, to be opened at New York, December 6, 1904," and let us imagine the innumerable data specified in each of those complicated documents expressed in metric terms (if it were possible in the state of the art to do this with necessary accuracy), and then watch the manufacturer who examines the varied requirements, all stated in a new and foreign language of technical terms, weights, and measures, and consider whether he can make an intelligent bid for supplying the Government with the few articles specified in those documents. His goods are designed and finished by another system of measures, and if he desires to make a bid for these articles, he must go through almost endless calculations before he can determine practically whether he can make up the goods, and then another series of complicated calculations to enable him to determine the cost of manufacture; and as accuracy is a prime essential in filling Government contracts, he may well hesitate before placing himself in the power of an unbending inspector, and if he does finally conclude to bid, he must add a fair percentage to cover new and uncertain risks.

In the case of machines required by the Government for any given work, specifications would have to be expressed in metric terms, and in almost every item there would be some variation in the equivalents as between the old and new systems (the effect may be likened to the prodigious change in relations produced in a kaleidoscope by a single turn of that toy). The manufacturer, in order to meet such require-

ments, would have to modify his machine in some or many of its parts, or rebuild it entirely, and here is the point where the metric system would get in its fine work to the serious and almost endless derangement of all existing factory calculations. Not every manufacturer could afford to modify his plans and tools in order to do Government work. In many cases there would not be enough of it the year round, and to that extent competition would be eliminated and the Government would be forced to pay the difference.

You may say that I magnify obstacles. I can not. They are so great and numerous that it is not possible to overstate their importance. The predominating commercial element of the world is Anglo-Saxon. That contrilling element uses the English system and is contended with it. If the minority (not Anglo-Saxon want the metric system, let them have it; but there is no reason in compelling our manufacturers to read specifications for United States Army and Navy and civil departments in a foreign language. The Anglo-Saxon measurements have done very well for this prosperous nation, and the writer voices the wish of a number of large manufacturers with whom he has talked on the subject, that you will not fasten the metric system upon the Government Departments with the resultant injury to the country's industries that in their opinion would be sure to follow. He has talked with only one manufacturer who favors the bill, and that gentleman, of large experience, and very intelligent and capable in his line, was educated as a civil engineer, and necessarily thinks in a technical language as distinguished from that of a practical manufacturer. This habit of scientific thought of course necessarily attaches to all scientists and others who consider questions from an academic standpoint. Of course there are gradations in this class, as in every other, but the fact remains that as whole, so far as the writer has studied the subject, practical manufacturers are against the adoption of the metric syetem in its present initial form, while scientific men, who do not have to pay the bills, are in favor of it. This is not accidental.

Finally, if the metric system is believed to be such a good thing, why not leave it to work out its own salvation instead of having the United States Government impose the cost of its adoption largely upon the manufacturers, who have troubles enough of their own in competing with foreign-made goods.

Yours, very truly,

WILLCOX & GIBBS SEWING MACHINE COMPANY,
D. H. BATES.